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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2002 (28.03.2002)

PCT

(10) International Publication Number
WO 02/24529 A1

(51) International Patent Classification⁷: B64D 39/00

(21) International Application Number: PCT/CA01/01330

(22) International Filing Date: 21 September 2001 (21.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/234,252 21 September 2000 (21.09.2000) US

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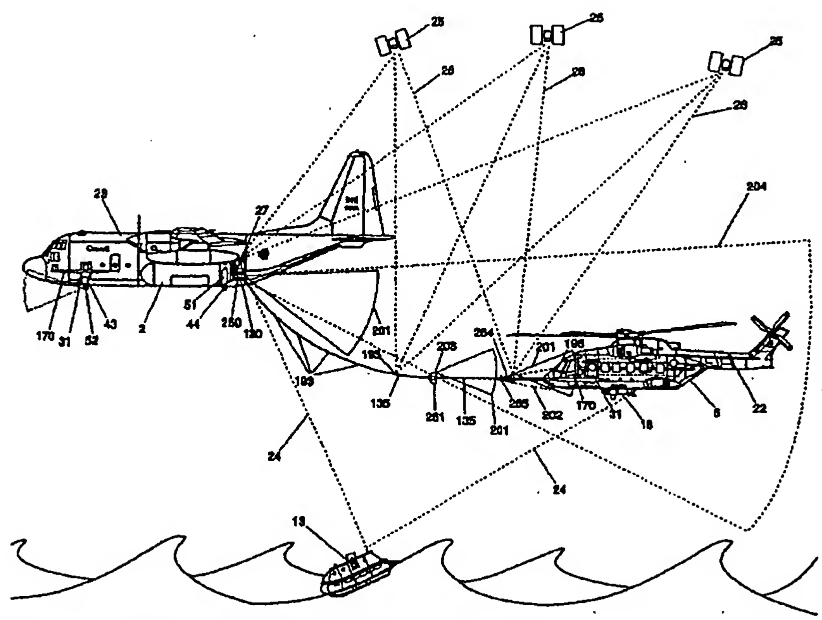
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ROLL ON - ROLL OFF, PORTABLE AERIAL SPRAYING, PARTICULATE DISPERSAL, AND REFUELING SYSTEMS APPARATUS



(57) Abstract: This invention relates to a new design and integration approach in the configuration, capability, and side door, hatch, or other removable pressurized plugs, useful for mounting and operating various types of roll on roll off airborne refueling systems, spraying systems, dry particulate diffusion systems, and fluid spray dispersal systems for use with aircraft in support of search and rescue operations and other missions.

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ROLL ON - ROLL OFF, PORTABLE AERIAL SPRAYING, PARTICULATE DISPERSAL, AND REFUELING SYSTEMS APPARATUS

Richard L. K. Woodland

FIELD OF THE INVENTION

This invention relates to an integrated, uniform, removable, portable, roll on and roll off, modular, mounting suite of aircraft-based hardware for air to air refueling systems, aerial spray systems, and dry chemical aerial dispersal systems.

BACKGROUND OF THE INVENTION

Fixed and rotary wing aircraft typical of the Lockheed-Martin C-130, have been extensively modified to undertake a number of different aerial response missions which involve spraying liquid, and dispersing dry chemical, oil coagulating agents, or organic particulate, fertilizer agents, bio-remediation agents, pesticides, herbicides, defoliants, and other products from airborne delivery platforms using Roll On Roll Off spray systems, and like temporary mounted aircraft installations. Further, aircraft are extensively used around the world to undertake dynamic in flight refueling of other aircraft, using female to male drogue refueling baskets typical of systems manufactured by the Aero Union Corporation Of California, or male to female refueling probes typical of those manufactured by the Boeing Corporation of Washington.

In many Air Forces, due to high operating costs, limited aircraft acquisition, training, and maintenance support funding, there are only a limited number of aircraft, which, by necessity, can be used for multiple roles using the same flight crews. An example of this situation, involves the thirty two, Lockheed-Martin C-130 aircraft of the Canadian Air Force, which are regularly used for humanitarian relief operations, search and rescue, military air lift, aerial refueling, emergency medical transport, passenger operations, and other applications. With particular emphasis on search and rescue, it is imperative that such aircraft are equipped with sensors for all weather detection of persons in peril particularly in hostile marine situations, which typically take place some distance from land. Under such circumstances search and rescue helicopters have limited range, and even if equipped with refueling systems, must be accompanied by a refueling tanker to provide fuel when

the helicopter is offshore. Although other methodologies for ship based refueling operations have been devised to provide fuel from ships to helicopters by means of a snorkel assembly, ships are not as mobile as aircraft, especially in rough weather, and even faster military ships will typically take ten times longer than a Lockheed-Martin C-130 to traverse the same distance. Hence an acute problem exists wherein the capability to conduct search and rescue missions using advanced sensor suites, while providing simultaneous air to air refueling to other search and rescue aircraft, and being able to receive fuel from other aircraft, without modifying the airframes, and permitting rapid reconfiguration for other operations. Such a system does not currently exist.

Although other roll on roll off systems for C-130's have been designed for aerial spraying, and the temporary storage of fuel, these systems are not modular as to permit interoperability (spraying to refueling etc.) using the same mounting components, or without modifying the aircraft. Typically these modifications involve expensive installations for aircraft plumbing, pumping systems, storage tanks, and auxiliary power systems typical of those manufactured by Sargent Fletcher of the USA for, aerial refueling. Wing mounted refueling pods typical of those manufactured by Aero Union and Sargent Fletcher, are currently used on Lockheed-Martin C-130 and like aircraft, but also result in increased aerodynamic drag, the installation of hardpoints, pylons, additional structural weight, and permanent plumbing. These modified or dedicated aircraft platforms, can cause delays or cancellation of specialized missions due to aircraft maintenance problems, and thereby result in the acquisition of fewer aircraft to undertake these unique missions.

Further, search and rescue operations depend heavily upon helicopters for extracting persons in peril, particularly in marine environments where high sea states prevent other forms of surface extraction. Although helicopter aerial refueling systems comparable to those described by Piasecki, in **U.S. Patent 5393015**, issued on Feb. 28, 1995, entitled "Rotary Wing Aircraft In-flight Refueling Device", have aided considerably by extending the range of helicopters to effect long range rescue at sea, on several occasions, the effect of high wind, poor visibility, and the turbulent effect of said wind on the delivery aircraft, receiving helicopter, drogue, and hose dynamics have prevented aerial refueling, which in one case resulted in

the ditching and subsequent l ss of a U.S. Air National Guard Pave Hawk H-60 search and rescue helicopter. In several other instances aerial refueling has been undertaken at considerable risk to helicopter and crew, where on several occasions helicopter rotors have connected with, or cut the refueling hose in half resulting in loss of the helicopter, due primarily to the curvature of the refueling hose from the delivery aircraft. In one particular case a U.S. Marine Corp. CH-53 helicopter was actively engaged in pursuing the refueling drogue and began to undertake such violent vertical maneuvers that the flexure of the rotors severed its own refueling probe. There are many documented aerial refueling accidents involving helicopters, which could have been prevented by a flat section of fuel hose and a flyable drogue, which could provide a degree of stability in turbulent air, particularly in low altitude marine rescue situations. Such a system does not currently exist.

Although the Boeing Corporation of Seattle, Washington USA, has devised a methodology of deploying a single refueling hose and drogue assembly through the floor of a V-22 Tilt Wing Rotor aircraft, the system cannot provide redundancy. The importance of redundancy and the hydraulic methodology used in reel based refueling systems as proposed in Boeing's brochure "V-22 Medium Lift Fuel Dispensing System (MLFDS)" and disclosed as same at the Aerial Refueling Systems Advisory Group (ARSAG) conference, in Phoenix, Arizona, September 18, 2000, has been cited by the U.S. Air Force in document **HQ ACC/DRS,17-20** as "unreliable", and further, the existing FR-300 pod system was noted as having a Mean Time Before Failure (MTBF) of only 49 hours, in U.S. Air Force document **HQ ACC/DRS, 19**.

Further in the white paper published by Major Tracy W. Colburn in March of 1997, entitled "Running On Empty: The Development Of Helicopter Aerial refueling And Implications For Future USAF Combat Rescue Capabilities", prepared for the U.S. Air Force Air Command And Staff College, document reference **AU/ACSC/0412/97-03**, Major Tracy cited several instances where helicopter rescue, and training missions were compromised because of inoperable refueling equipment. Given the potential for catastrophic loss of an aircraft and crew because of failure of a refueling delivery system to provide fuel to a receiver aircraft, a need exists to install redundant refueling capabilities in any potential refueling tanker delivery aircraft. The MLFDS proposal by Boeing does not provide

or intimate redundant capability. Further, Boeing fails to disclose and provision for manned observation, a flyable downrigger or drogue assembly, low profile fuel tanks, and further fails to disclose graphically or texturally a pressure housing to provide the V-22 with pressurized aerial refueling operations.

Another problem associated with airborne refueling systems, particularly for search and rescue, and special missions, involves the inboard palletized fuel tank reservoirs on Lockheed-Martin MC-130 or like aircraft which typically use round cylindrical tanks which are not designed for simultaneous use of the rear of the aircraft for cargo, passengers, or other equipment which may be used in conjunction with the air refueling capability. Other problems associated with inboard fuel tanks, or temporary bladders is that in an accident, the higher center of gravity of the cylindrical tanks, makes them more prone to separate from their support structure and suffer structural damage or rupture accordingly in an accident. Under said accidental circumstances, or from hostile gunfire, for example, on humanitarian relief operations, as was experienced by relief flights in Bosnia, Somalia, and Kenya within recent years, said single layer, ballistics unprotected tanks once ruptured, can result in fire and explosive detonation of the fuel. Further, most roll on roll off fuel tanks do not incorporate structural reinforcing for heavy cargo which could be loaded on top of the fuel tanks, thereby making better use of the currently unusable space, aboard the aircraft. In light of the foregoing, existing palletized cylindrical or other fuel tanks do not incorporate topside roller bearing handling systems, integrated cargo handling rails, ballistics protection, or fireproof linings.

Further, several types of existing aircraft like the U.S. Air Force Lockheed-Martin C-130 aircraft which are equipped with female fuel receptacles, require dedicated, articulated male refueling probe transfer systems installed on host aircraft like Boeing KC-135's which are uniquely configured with said dedicated, articulated, telescopic refueling booms. A roll on roll off articulated boom, male probe refueling system does not currently exist. Further, a combined non dedicated, NATO compatible drogue female refueling assembly, combined with the U.S. Air Force standard articulated boom with male probe refueling assembly would also decrease the numbers of different types of refueling aircraft and permit a high

level of joint interoperability. However, such a combined male and female refueling boom assembly doe not currently exist.

Further, Lockheed Martin C-130 aircraft, are also used for aerial spraying applications which utilize roll on spray systems like the ADDSPak system employed by the Alyeska Pipeline company, In Alaska or other systems comparable to the Modular Airborne Spray System (MASS) in use with the U.S. Air Force Reserve 910th Airlift Wing, in Ohio. However, the MASS system requires airframe modifications and plumbing to be installed through the wings and aircraft fuselage of the Lockheed-Martin C-130. The ADDSPak system also requires pre-deployment of the spray rails on the ground which are typically deployed through the rear ramp of C-130 aircraft. Said cargo ramp is left open throughout the entire flight envelope, thereby compromising aircraft pressurization, increasing drag and resulting in cumbersome handling characteristics, restricted flight altitudes, and slower transit speeds.

Further, low cost weapons of mass destruction (WMD) and combative tactics employed during the Iraq war, by terrorists, and recent wars in other countries, present unique challenges to rapid reconfiguration of spraying aircraft. For example, U.S. military experts found that Iraqi Mirages were given spray tanks to disperse biological agents and accordingly held trials as late as January 13, 1991 and further incorporated an ability to refill the Mirages with additional biological agents by air. It is documented by the U.S. military, and other United Nations specialists, that Iraq Manufactured tens of thousands of liters of concentrated Botulinium toxin, anthrax, and Aflatoxin, clostidium perfringens, a gangrene-causing biological agent, and concentrated Ricin, in solution during the early 1990's within Iraq's borders.

In Japan the terrorist group "Aum Shinrikyo" initiated chemical attacks in June 1994, in Matsumoto, Japan, which killed seven people and injured 500. Plans of the Aum Shinrikyo were discovered which revealed that they planned to produce enough Sarin gas agent to annihilate a large Japanese city by spraying it from a helicopter. These were the first instances of large-scale terrorist use of chemical agents, but a variety of incidents and reports over the last two years indicate a growing terrorist interest in these weapons. A rapidly configured, roll on, non dedicated, aerial spray system which can be loaded onto an aircraft of opportunity

like a Lockheed-Martin C-5 Galaxy in minutes, not hours, to apply aerial neutralizing agents for biological, chemical or radiation threats, without requiring any airframe modifications, does not currently exist.

In other areas, spray systems are critical in protecting agriculture crops or destroying illegal drugs. For example according to the U.S. Drug Enforcement Administration, in addition to coca production, Colombia now ranks fourth, among the world's heroin producers. Colombia pursues an active aerial eradication program and sprayed approximately 8,000 hectares of cultivated poppies in 1998. Although aircraft like Cessna A188B Ag Trucks have been created or modified as dedicated spray aircraft to undertake smaller more select aerial spraying applications, the prolonged nature and high volume of some spraying operations, and the need for non dedicated roll on capabilities require a different approach to aerial spraying systems.

Further the spray rails, which are fixed or temporarily mounted in some aircraft, require that the host airframe be flown at a slower speed due to the aerodynamic forces exerted upon the spray rail assembly, and open ramps, and doorways. Hence a spray system, which does not use rails, or require open doorways, or unpressurized flight, particularly among roll on systems does not currently exist.

Further no combined, unmodified, roll on aerial spray and dry chemical dispersal system, currently exists which possesses the capability of providing a GPS coordinated reference system to affect automatic computer controlled flow of dry particulates or spray fluids, which further interfaces with the aircraft autopilot, to initiate dispersal over an electronic geographically controlled delivery area, with variable dispersal rates to accommodate differential dispersal on varying densities of nuisance or illegal plants, pests, or lethal chemical, biological and other aerosol warfare agents on the ground or within the air within the delivery zone. Further no capability exists to integrate a temporarily mounted ballistic winds sensor package with the capability of reading the wind miles ahead of the host spraying aircraft to create a three dimensional matrix of wind currents, wind direction, and wind velocities to dynamically plot the optimum aircraft approach, dispersal or spray pattern, and flow rate, when given said variable wind parameters.

Further no roll on spray or particulate dispersal system exists which also incorporates a means for accommodating a non dedicated in flight sensor to detect, analyze, characterize, and track, lethal airborne aerosols, or particulate matter, as part of a homogeneous roll on response capability.

All of the aforementioned special mission work systems are currently non existent, or are expensive, requiring dedicated airframes, which restrict aircraft performance, decrease safety margins, and inhibit mission readiness.

Accordingly there is a continuing unaddressed need for a common aircraft mounting system which is highly portable, pressurized, and moves seamlessly between aircraft, and utilizes side door, or other fuselage orifice mounting methodologies which do not require airframe modifications, and incorporates the capability to undertake interchangeable applications for; refueling, refueling guidance, refueling hose stabilization, spraying, particulate dispersal, spraying, dispersal zone sensing, planning, and delivery, in conjunction with the simultaneous carriage of cargo, medevac or other parallel systems in conjunction with refueling, spraying, or particulate dispersal missions.

BRIEF SUMMARY OF THE INVENTION

The current system solves the problems associated with fixed mount refueling, spraying, dry chemical or particulate dispersal systems, used in conjunction with aircraft, which are specifically modified to undertake these missions. The preferred embodiment of the current invention builds on previous patents by Richard L.K. Woodland (US patent 5927648 entitled; "Aircraft Based Sensing, Detection, Targeting, Communications, And Response Apparatus" and the improvement copending U.S. Patent Application Serial No. 08/731,684 entitled; "Portable Sensing, Communications, And Electronics Intelligence Aircraft Pod Apparatus") which address non dedicated, roll on roll off, pressurized, articulated mechanical mounting systems and process methodologies.

The preferred embodiment of the current invention solves the aforementioned dedicated airframe issues, and permits government authorities, and private operators to undertake response missions, and maximize utilization of cargo and fuel carrying capabilities without modifying the host aircraft. Said system achieves this enhanced portability and mission diversity by meeting the following objectives;

Objective One – minimize or eliminate the requirement for aircraft structural, electrical, and plumbing modifications associated with airborne spraying, refueling, and particulate dispersal.

Objective Two – Maintain aircraft pressurization throughout the entire flight envelope while minimizing induced drag caused by external system appendages.

Objective Three – Enhance simultaneous inboard fuel and cargo carrying capabilities, and reduce the massing envelope of current temporary roll on fuel tank system installations.

Objective Four – Enhance the safety characteristics of current temporary roll on fuel tank system installations, particularly as they relate to ballistics, fire, and crash survivability.

Objective Five – Enhance the versatility of current single mission aircraft platforms, and roll on spray systems to undertake dry particulate dispersal, wet fluid spraying, interoperable NATO and U.S. and Air Force air to air refueling.

Objective Six – Enhance the portability and optimum location of the user interface control assembly for aerial spraying, particulate dispersal, and air to air refueling with particular attention focused on creating improved, direct operator standard daylight and night vision goggle visibility of the air to air refueling operation while maintaining close proximity to said portable user interface assembly.

Objective Seven – Enhance precision host and recipient aircraft positioning and guidance prior to and during air to air refueling operations.

Objective Eight – Enhance the in flight aerodynamic stability and control of the NATO compliant female drogue basket during the air to air refueling process.

Objective Nine – Create a means for simultaneous non dedicated, aircraft sensor utilization and mounting, with accurate GPS based spray dispersal patterns and precise positioning capabilities for air refueling, spraying and dry particulate dispersal.

The foregoing objectives are achieved by the preferred embodiment of the present invention which undertakes the integration of novel technologies, systems, and assemblies, without modifying the aircraft, and uses existing palletized cargo loading and handling systems familiar to those skilled in the art of roll on roll off and cargo restraint systems, to undertake temporary installation of the various work response systems. The preceding nine objectives, are achieved by the following components and assemblies,

1) a temporarily mounted, pressurized, roll on roll off, door, panel, or hatch mounted low profile, closed system pressurized, conformal fairing with a flight controllable, female drogue, hose, reel, drogue stabilization system, and guidance positioning assembly such that it does not affect aircraft pressurization,

2) a temporarily mounted, pressurized, roll on roll off, door, panel, or hatch mounted fairing, with articulated, multi axis, telescopic boom, with male and female refueling probe and collapsible drogue and hose assembly, with stabilizing aerodynamic control surfaces to maintain and otherwise remotely trim the position of the refueling boom and drogue assembly,

3) a temporarily mounted, pressurized, roll on roll off, side door mounted articulated fixed mount or telescopic strut or fairing, with multi function capabilities to accommodate a low drag refueling fairing, a refueling pod assembly, a spray assembly, and a dry chemical particulate diffuser assembly,

4) a temporarily mounted, segmented, interconnected, roll on roll off, fire proof, bullet proof, explosion resistant, structurally reinforced, internally baffled, low profile fluid reservoir tank assembly capable of accommodating fuel, chemicals, bioremediation agents, or other liquids, in conjunction with heavy cargo, or passengers on the upper side of said temporary tank assembly,

5) a temporarily mounted, segmented, interconnected, roll on roll off, internally tapered, dry reservoir tank assembly with a pressurization system, and an auger dry particulate feed assembly which can simultaneously accommodate heavy cargo, or passengers on the upper side of said installed temporary tank assembly,

6) a temporarily mounted, pressurized roll on roll off, ram air actuated, low profile, hydraulic, or electrically driven support capability for spraying, refueling, and dry chemical dispersal assembly,

7) a temporarily mounted, portable GPS system used in conjunction with refueling, spraying, and particulate dispersal systems.

8) a temporarily mounted, pressurized door, hatch, or removable panel with the capability of accommodating an operator's seat, a large flat, or protruding observer bubble window, which is used in conjunction with, and for the purpose of observing the, refueling, spraying, and particulate dispersal systems when deployed in flight.

9) a temporarily mounted, portable user interface system used in conjunction with an infra red, and video monitoring system, or other imaging sensor, and refueling, spraying, and particulate dispersal systems.

10) a temporarily mounted, portable Low Light Television (LLTV) and eyesafe laser ranging system with micro miniature range detecting radar chips and infra red proximity lighting system attached to an articulated male

refueling probe or a female drogue basket and hose assembly which is used in conjunction with refueling systems to determine the proximity of the receiving aircraft to the refueling delivery assembly.

The integration of the foregoing systems, embodied as interchangeable assemblies within the present invention, achieve the foregoing objectives, and provide the roll on roll off capability, with spraying, dry particulate dispersal, and interoperable male, and female refueling capability from one aircraft platform.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 – Is a side view of a Lockheed-Martin C-130 fixed wing aircraft with portable infra red search sensor, a rear ramp roll on, conformal, female drogue assembly variant of the present invention, deployed to effect refueling of a rotary wing Augusta-Westland EH101 Helicopter equipped with a search and rescue radar and infra red sensing pod, roll on male refueling probe assembly of the present invention.

FIG.2 – Is a side view of a plan view of a Lockheed-Martin C-130 fixed wing aircraft with a portable, forward side door mounted male probe fuel receiving system, and a rear side door pressurized, conformal, female drogue assembly variant of the present invention, deployed through to effect simultaneous refueling of two EH-101 Cormorant search and rescue helicopters depicting flyable drogues to separate the two helicopters which are used in conjunction with the present invention.

FIG.3 – Is a frontal view of a Lockheed-Martin C-130 engaged in refueling two EH-101 Cormorant search and rescue helicopters, depicting helicopter separation, and side mounted fairings equipped with telescopic, retractable sensors.

FIG. 4 – Is a perspective cutaway internal view of a Lockheed-Martin C-130 equipped with various refueling, observation, and fluid tank components of the present invention.

FIG. 5 - Is a cross section view through a Lockheed-Martin C-130 or like aircraft, depicting the various pallet mounted, pressurized pod and reel refueling, operator interface, observation, mounting, articulation, and typical medevac container components of the present invention.

FIG. 6 – Is a cross section of a typical aircraft equipped depicting an articulated strut and self-contained externally mounted refueling pod, which does not require internal pressurized housings.

FIG. 7 – Is a perspective view of a low profile fluid or dry particulate tank depicting integration of cargo handling systems.

Fig. 8 - Is a perspective view of a low profile fluid or dry particulate tank depicting the internal configuration and baffle assembly.

FIG. 9 – Is a perspective view of a low profile fluid tank configured for spraying applications depicting pumping, pressurization, spray nozzle and fairing assemblies.

FIG.10 - Is a plan view of a Lockheed-Martin C-130 configured for spraying applications depicting aircraft vortices locations, spray nozzle dispersal patterns and fairing assemblies.

FIG. 11 - Is a perspective view of a the internal workings of an auger and pressurized dry particulate dispersal tank and fairing assembly

FIG. 12 - Is a perspective view of the internal workings of an auger and pressurized dry particulate dispersal tank with door mounted hopper feed system and fairing assembly.

FIG. 13 – Is a perspective view of a composite observer door panel, and refueling fairing equipped with a retractable sensor gimbal assembly.

FIG. 14 - Is a perspective cutaway view of a composite observer door panel, and combined portable fairing assembly equipped with a high pressure, spray system and aerial refueling assembly.

FIG. 15 – Is a perspective view of an observer door panel, and portable fairing assembly equipped with an aerial refueling assembly, hose and drogue.

FIG. 16 – Is a perspective view of a conventional fluid tank and pumping system, with an articulated telescopic or fixed length strut with multiple spray nozzles, dry particulate diffuser, and JATO stabilization strut attached to a pressurized door plug.

FIG. 17 – Is a frontal view Lockheed-Martin C-130, depicting simultaneous refueling of two EH-101 Cormorant helicopters, denoting articulated strut and refueling fairing assemblies in the upper an lower positions respectively to provide aircraft separation.

FIG. 18 – Is a perspective view of a Lockheed-Martin C-130 equipped with a pressurized door plug assembly refueling two EA-6B's using externally mounted refueling pods on articulated struts.

FIG. 19 – Is a Lockheed-Martin C-141 equipped with two articulated struts refueling a Lockheed-Martin C-130 aircraft, and an EH-101 Cormorant helicopter.

FIG. 20 - Is a Boeing C-17 equipped with a portable pressurized door and refueling fairing assembly engaged in the process of refueling a United States Coast Guard Sikorsky - H-60 Jayhawk helicopter equipped with a refueling probe equipped temporary fuel pod typical of those manufactured by Sergeant Fletcher.

FIG. 21 - Is a C-130 aircraft equipped with an articulated male and female refueling boom engaged in the process of refueling a Lockheed-Martin C-130 Aircraft with the drogue basket retracted and collapsed, and the male probe extended for a USAF standard refueling operation.

FIG 22 - Is a C-130 aircraft equipped with an articulated male and female refueling boom engaged in the process of refueling a USCG Sikorsky H-60 Jayhawk helicopter with the male probe retracted, and the drogue basket and hose assembly extended for a NATO standards refueling operation.

FIG. 23 – Is a perspective view of a removable, portable chair mounted user interface assembly in the open and installed configuration depicting various tactile display interfaces.

DETAILED DESCRIPTION OF THE INVENTION

The invention is now described in terms of the FIGURES to more fully delineate in more detail the scope, materials, conditions, and methods of the present invention. Many of the parts and components of the present invention are hereinafter described as being "assemblies." As used herein, the word "assembly" or "assemblies" refers to the totality of related parts and pieces related to a given component and its operability, and is not to be considered as limiting to a particular part, piece, or operation.

INTEGRATED MISSION SYSTEM - In general, the invention comprises a novel design and integration approach in the configuration, capability, and operation of side door, hatch, or other removable pressurized plugs, useful for mounting and operating various types of roll on roll off airborne refueling systems, spraying systems, dry particulate diffusion systems, and fluid spray dispersal systems for use with aircraft in support of search and rescue operations and other missions. One such roll on refueling configuration denoting a fuel delivery aircraft, and a fuel recipient aircraft, is shown in FIG. 1, where a search and rescue Augusta Westland EH101 Cormorant Helicopter **5**, equipped with a temporarily mounted Sensor Pod Assembly **18**, typical of sensor pod systems disclosed by Woodland in the copending **U.S. Patent Application Serial No. 08/731,684**, is being refueled by a search and rescue Lockheed-Martin C-130 Aircraft **2**, equipped with a side door Gimbal Sensor **44**, mounted on the forward crew door, and a JATO Telescopic Sensor Fairing Assembly **51**, temporarily attached to the JATO Mount **226**, wherein neither aircraft has been modified to undertake the combined search and rescue, and air to air refueling missions. Further mounting and installation methodologies have not hindered, or compromised search sensors, communications, equipment stowage, or air-drop and telemetry of a Marine Rescue Vehicle **13**, and associated Marine Rescue Vehicle Telemetry **24**, capabilities.

TANK & PUMPING MODULE SYSTEMS - In conjunction with or without the use of said side door Gimbal Sensor **44**, and, or Sensor Pod Assembly **18**, the preferred embodiment of the present invention is further described in FIGs. 4, 5, 7, 8, 9, 11, and 12, wherein a plurality of, multi mission refueling, spraying, and dry particulate dispersal capable, interconnected, segmented, structural low profile Flat Top Tank

Assembly **60**, means, are fastened to, or otherwise integrated with a Mounting Pallet **33**, means which is installed on board an aircraft, by means of the lower rear ramp, of a Lockheed-Martin C-130 Aircraft **2**, using the A/A32H-4A Cargo Handling System **34**. Said Flat Top Tank Assembly **60**, means being structurally engineered to support, by means of honeycomb and other structurally sound construction methodologies familiar to those skilled in the art of aircraft structures engineering, the carriage of cargo on top of the Segmented Low Profile Tank **61**, and to further provide a protective and structural support for fluids, or particulate matter carried inside said Segmented Low Profile Tank **61**. Said engineering methodologies and structurally sound practices as they pertain to composite materials are disclosed by Morrisey, in **U.S. Patent 4511105**, issued on April 16, 1985, entitled "Compartmented, Filament Wound, One Piece Aircraft Fuel Tanks" which are portable, but external to the aircraft, and do not address the integration of cargo carrying or handling characteristics.

Removable Tank Baffles **66**, provide additional structural support and serve to reduce unwanted movement of the fluid contained within the Segmented Low Profile Tank **61**. Said Segmented Low Profile Tank **61**, being equipped with lower and upper A/A32H-4A Cargo Handling System **34**, ADS rails, and upper Cargo Bearings **49**, systems which are familiar to those engaged in the art of cargo handling, which are used to secure, mission packages, Mounting Pallet **33**, systems and cargo on top of the low profile Flat Top Flat Top Tank Assembly **60**, means. A means for addressing the necessity of having rapid assembly fuel tanks in a combative environment is disclosed by Arnold, in **U.S. Patent 4790350**, issued on December 18, 1988, entitled "Combat Rapid Assembly Fuel Tank" which incorporates a pylon mounted, collapsible, rapid assembled, bladder and pod based fuel tank. However, there is no consideration given to ballistics or fire protection. In light of this requirement, particularly in hostile operating areas, As depicted in FIG. 4, said portable roll on roll off Segmented Low Profile Tank **61**, incorporates a basic Structural Housing **64**, with multiple, optional layers of internally or externally laminated, or fastened material, including a Ballistic Lining **62**, typically comprised of Spectra Fiber manufactured by the Du Pont Corporation USA, to prevent the penetration of ballistic munitions, and a Fire Proof Lining **63**, typically comprised of refractory ceramic fiber blanket encapsulated with aluminum foil, manufactured by the 3M Corporation of the USA, to prevent said Segmented

Low Profile Tank **61**, from detonating as a result of external fire in a crash situation. The structural composition of said Segmented Low Profile Tank 61, may consist of ferrous or non ferrous metals, composite, or plastic materials which are capable of meeting the structural engineering requirements of the present invention, and are familiar to those skilled in the art of fabricating fuel tanks, .

Further, in the preferred embodiment of the present invention the Segmented Low Profile Tank **61**, can be augmented by a second internal, flexible form and volume compliant Bladder Tank **68**, similar to those described by Crago et.al. in **U.S. Patent 5205427**, issued on April 27, 1993, entitled "Modular Fuel Tank System" which discloses a pylon mounted, collapsible, rapid assembly, bladder pod fuel tank for external carriage, and no cargo capability. Said volume compliant Bladder Tank **68**, incorporates a plurality of Removable Tank Baffles **66**, which fold down with said Bladder Tank **68**, for storage when it is emptied of fluids. Said Bladder Tank **68**, particularly conforming to the lower periphery of the Segmented Low Profile Tank **61**, Sump Taper **80**, to facilitate liquid or dry particulate removal. Said Segmented Low Profile Tank **61**, being internally lined with a bladder to permit and otherwise facilitate the utilization of the same structural tank assembly for potable water, alternate chemicals, and different fuel types by simply replacing the Bladder Tank **68**, without requiring a dedicated structural tank for each application. Said use of a bladder lining also serves to prevent tank corrosion when potentially corrosive agricultural, herbicides, pesticides, spray chemicals or Nuclear, Biological, and Chemical neutralizing agents are employed with the Spray System Assembly **210**. Said Bladder Tank **68**, or Removable Tank Baffles **66**, being replaced by removing or opening the Flat Tank Lid **76**, which can be locked and pivotally hinged to remove a first Bladder Tank **68**, and installing a second Bladder Tank **68**, or Installing a Dry Tank Assembly **90**, kit, consisting of a Dry Particulate Duct **93**, an Auger Assembly **94**, and a Contoured Dry Tank Liner **95**, which when installed, converts the Segmented Low Profile Tank **61**, into a dry particulate dispersal system.

The Segmented Low Profile Tank **61**, is pressurized by means of a Compressor And Pressurization System **69**, which charges the Segmented Low Profile Tank **61**, with inert gas to further inhibit explosion and facilitate discharge of the liquid, or dry particulate matter. Such a methodology is disclosed by Goss, **U.S.**

Patent 6021978, issued on Feb. 8, 2000 entitled "Anti-Explosion Protection System For Flammable Vapors".

The fluid, dry particulate, or fuel contained within the Segmented Low Profile Tank 61, or Bladder Tank 68, will gravity drain to a Sump 65, which is connected to a universal Pipe Connection Outlet 96, located at the Sump 65, at the end of the Sump Taper 80. Fluid or particulate matter at the Sump 65, is discharged under pressure into the Fluid Piping 71, or Dry Auger Feed System 92, which will in turn deposit said dry particulate matter into a Door/Pallet Mounted Hopper 97, or directly off board of the aircraft to the spraying or diffusing discharge means.

With the appropriate Bladder Tank 68, any number of pumping or processing modules may be integrated with the universal Pipe Connection Outlet 96, including but not limited to an Airborne Fuel Pumping Module 70, for air refueling operations, a Dry Auger PTO Module 91, for dry dispersal operations, a Spray Fluids Pumping Module 86, for aerial spraying applications. The discharge force in either a dry or fluid configuration for airborne applications, is provided by said Spray Fluids Pumping Module 86, or an Airborne Fuel Pumping Module 70, or a Dry Auger PTO Module 91, and augmented by high pressure air from the Compressor and Pressurization System 69. Said Compressor and Pressurization System 69, also provides a means to purge residual fluids and particulate matter from the tanks, bladders, ducts, and piping, which discharges excess fluid out the side door of the aircraft.

Liquid pumping system modules may also effect pumping of fluid to other Segmented Low Profile Tank 61, means for the purpose of transferring fuel or other liquids from the tank for discharge through the air to air refueling system, or spray system, to other on board tanks, or for ground based fuel transfer. Said Compressor And Pressurization System 69, Spray Fluids Pumping Module 86, and Airborne Fuel Pumping Module 70, preferably being of variable flow, constant flow configuration to permit the system operator to dynamically define discharge rates, and maintain a constant rate of discharge. Another advantage of using a plurality of interconnected Segmented Low Profile Tank 61, means permits the carriage of different types, and proportions, of chemicals and water, which can be selected, and discharged as blended or mixed fluids accordingly, and moved from one tank to another as defined by the system operator. Said internal fluid transfer

methodologies being familiar to those skilled in the art of aerial refueling and spraying.

Said simultaneous cargo carrying features are depicted in FIG.5 wherein a cutaway view of a Lockheed-Martin C-130 Hercules **2**, depicts the simultaneous stowage of a Segmented Low Profile Tank **61**, means, in conjunction with a Medevac Container **14**. Although Colombo et. al, in **U.S. Patent 4458864**, issued on July 10, 1984 entitled "Medical Complex For Installation In A Standard Aircraft To Convert It Into An Ambulance Aircraft", the disclosure by Colombo et. Al, of the roll on medevac capability container, does not include integration of the medevac capability with Segmented Low Profile Tank **61**, means, or other sensor and fuel refueling receiving, or delivery systems.

Various other emergency response equipment and container assemblies, including but not limited to' M-2 Marine Rescue Vehicle's, as disclosed in the U.S. patent issued to Woodland on January 28, 1997, entitled "Marine personnel rescue System And Apparatus", or other search & rescue equipment containers, and packages may also be carried in conjunction with the Segmented Low Profile Tank **61**.

<u>MOUNTING SYSTEMS</u> – As denoted in FIGs. 1 through 5, 9, and FIGs. 11 through 16, the preferred embodiment of the current invention incorporates a modular side door, or Pressurized Plug **31**, assembly which can be adapted for mounting on any number of airframe types including a fixed wing aircraft comparable to a Lockheed-Martin C-130 Aircraft **2**, or a rotary wing aircraft comparable to an Augusta Westland EH101 Cormorant Helicopter **5**. Said Lockheed-Martin C-130 Aircraft **2**, can be equipped with a Refueling Probe Receiving System **170**, which uses a Carter USA, Type MA-2 or Parker Aerospace of California USA MA-2 nozzle assembly, which is temporarily mounted in the forward crew doors on said aircraft or other fuselage orifices in conjunction with the simultaneous mounting of a pressure plug or side door Conformal Refueling Assembly **130**. Alternatively, as depicted in FIG.21, a USAF standard Female Fuel Receiving Receptacle **180**, capability can be adapted with aerodynamic fairing for installation in the upper ditching hatch of a Lockheed-Martin C-130 Aircraft **2**, or like aircraft using the "Universal Aerial Refueling Receptacle Slipway Installation

(UARRSI)" manufactured by the Parker Hamilton Corporation, of California, USA, which can receive fuel from probe equipped tanker aircraft.

In other aircraft which are not equipped with rear loading ramps, for example a Lockheed-Martin P-3 Orion, aircraft, multiple smaller versions of the segmented tank refueling concept, can be loaded through the crew door to effect temporary installation on dissimilar aircraft using a Pressurized Plug **31**, with comparable installation and identical pressure plug and refueling system mounting techniques. However, the present invention is principally intended for rear loaded, aircraft typical of Lockheed-Martin C-130 Aircraft **2**. The present invention also allows for use of common mounting components on several types of aircraft including the Lockheed-Martin P-3 Orion, which may, or may not have rear ramp capabilities but will generally incorporate basic mounting components used to deploy and control a work system, comprising a Mounting Pallet **33**, a Pressurized Plug **31**, a Bubble Observation Panel **282**, an Operator Seat **281**, to mount a System Interface Assembly **280**.

<u>MALE RECEIVING PROBE</u> - As depicted in FIGs. 1 through 4, 10, and 19, the preferred embodiment of the present invention incorporates a temporarily installed Refueling Probe Receiving Assembly **170**, primarily intended for helicopters, but also for other fixed wing aircraft also, which provides an ability to receive fuel from another aircraft without modifications. Although Garcia et.al. in **U.S. Patent 5810292**, issued on September 22, 1998, entitled "Aerial Refueling System With Telescoping Refueling Probe" disclose a portable female to male refueling pod with telescopic probe developed for Israeli Air Force Lockheed-Martin F-16's and applicable to other aircraft, the pod is external to the airframe, and requires plumbing to be installed in the wings and fuselage of the aircraft. By contrast the Refueling Probe Receiving Assembly **170**, requires no modifications and comprises a Cantilever & Flutter Isolation Armature **174**, to mount said Refueling Probe Receiving Assembly **170**, a Counterweight **175**, located on the inside periphery of the aircraft but preferably comprising a part of the Segmented Low profile Tank **61**, assembly to compensate for the weight of said probe, fuel, and armature assemblies, a Probe Fuel Pipe **176**, and Cantilever Support **177**, which connects with, and otherwise is reinforced and of suitable strength structurally as to transfer and sustain the static and dynamic loads of the Refueling Probe Receiving

Assembly **170**, fuel, and Cantilever & Flutter Isolation Armature **174**, to the Segmented Low profile Tank **61**, assembly and a Pressurized Plug **31**, which seals and otherwise provides a pressurized interface between the interior and exterior of the aircraft, and isolates vibration from the airframe using pneumatic, rubber, or oil filled isolation seals surrounding the periphery of the Cantilever & Flutter Isolation Armature **174**. Said fuel receiving capability may be attached directly to said Segmented Low profile Tank **61**, or alternatively be connected by Fluid Piping **71**, means, directly to the aircraft's integral fuel tanks. The Refueling Probe Receiving Assembly **170**, when used in a fixed length non-extendable configuration requires no actuation to extend or retract. However, if said Refueling Probe Receiving Assembly **170**, is required to be telescopic, this can be achieved by methodologies disclosed by Perrella, in **U.S. Patent 4540144**, issued on September 10, 1985, entitled "Telescoping Fuel Probe" where in fuel pressure acts as hydraulic agent to extend and retract the probe.

<u>CONFORMAL REFUELING ASSEMBLY</u> - As denoted in FIGs. 1, through 5, 13, 14, 15, and 20, the preferred embodiment of the present invention addresses a side door mounted Conformal Refueling Assembly **130**, comprised of a Conformal Fairing **131**, which can extend beyond the periphery of the door or hatch frame, however, said Conformal Fairing **131**, is small enough to be deployed in flight, through the host aircraft door orifice in the side of the fuselage as disclosed by Richard L.K. Woodland **US patent 5927648** entitled; "Aircraft Based Sensing, Detection, Targeting, Communications, And Response Apparatus" and the copending **U.S. Patent Application Serial No. 08/731,684**, wherein Woodland discloses a modular pressurized, door assembly with removable panels. Although aircraft like the Lockheed-Martin EC-130 intelligence and broadcasting aircraft have large ventral fuselage antenna fairings located aft of the paratroop doors, these are permanent installations and cannot be moved between aircraft. Further, although Moss et.al. in **U.S. Patent 5667170**, issued on September 16, 1997, entitled "Pod Mounted Refueling System" disclose a sideward, fuselage mounted, horizontally oriented pylon or strut with refueling pod, the Moss invention is not portable, creates increased drag, and requires airframe modifications. Hence, the present invention builds upon the novel nature of said removable panels and Pressurized Plug's **31**, to incorporate a Conformal Fairing Panel **132**, which provides a low aerodynamic drag structural mounting and housing meth dology for a female

drogue refueling system which deploys the Drogue & Hose Assembly **260**, from said Conformal Fairing **131**. The present invention also includes a Bubble Observation Panel **282**, which provides the system operator with both direct visual, and remote video observation of the refueling process. The fuel transfer mechanical actuating components are located within the periphery of the aircraft fuselage behind the Pressurized Plug **31**, and generally comprise a Hose Reel Assembly **133**, which deploys the Refueling Hose **135**, and associated hard or soft, Collapsible Drogue Basket **264**, from the trailing edge of said Conformal Fairing **131**.

Said Conformal Refueling Assembly **130**, in the preferred embodiment of the present invention can also be used in tandem with one or more prepackaged Refueling Pod **152**, means typical of the 1080 Refueling Pod manufactured by Aero Union of California, which as depicted in FIG. 5, which is mounted on a Refueling Pod Mounting Cradle **153**, and affixed to the Mounting Pallet **33**. Further said Refueling Pod **152**, means when mounted within the pressurized fuselage of an aircraft, is housed within a first Pressure Vessel **53**, means which forms the outside casing of the Refueling Pod **152**, and is further connected to a second Pressure Vessel **53**, means which encases the Refueling Hose **135**, and provides an enclosed Pressure Vessel **53**, conduit between the Refueling Pod **152**, and the Pressure Plug **31**, mounted within the orifice of the aircraft fuselage, as to seal the inboard refueling apparatus from the inside of the aircraft and maintain equilibrium with the outside ambient pressure at refueling altitude. Said Pressure Plug **31**, being attached to a Door Plug Mounting Bracket **54**, and a Door Plug Swivel Hinge **55**, and being moveably installed in the open paratroop doorway of, for example a Lockheed-Martin C-130 Aircraft **2**, Further said refueling, spraying, and diffuser system components including, Segmented Low Profile Tank **61**, Compressor And Pressurization System **69**, Airborne Fuel Pumping Module **70**, Fluid Piping **71**, Spray Fluids Pumping Module **86**, Dry Tank Assembly **90**, Dry Particulate Duct **93**, Dry Auger PTO Module **91**, Dry Auger Feed System **92**, and Compressed Air/Inert Gas Lines **87**, assemblies also comprise component parts of the overall system Pressure Vessel **53**, means for refueling, spraying, of dry particulate distribution. Said closed pressure system being engineered and manufactured to standards which permit maintaining fuselage interior pressure values exterior to the pressure system inside the aircraft, and maintaining exterior ambient air pressure values

inside the Pressure Vessel **53**, means throughout the entire reservoir, distribution, pumping, and dispersal or delivery syst m regardless of which spraying, refueling, or particulate dispersal application is being employed.

The means described for maintaining separate pressurization values inside said first and second Pressure Vessel **53**, means and the interface with the aircraft, is portable, and does not require alteration of installed aircraft pressurizations systems, or structural modifications to the airframe of the host aircraft. Further, as depicted in FIGs. 4 and 5, said Pressure Vessel **53**, means are also used to encase and maintain differential pressure between the interior cabin of the aircraft and the outside ambient air of the palletized Hose Reel Assembly **133**, and Refueling Hose **135**, in vertical, horizontal, single, dual, parallel, or perpendicular mounting and orientation configurations of the Hose Reel Assembly **133**, in a manner comparable to that described for achieving differential pressure for the Refueling Pod **152**, when mounted inboard of the aircrafts pressurized fuselage. Said pressure Vessel **53**, being equipped with a variety of plumbing, electrical, data, and mounting means common to those involved in engineering and manufacturing aircraft pressure structures.

In order to meet or augment pumping and refueling operations power requirements a Ram Air Turbine **231**, as depicted in FIG. 13, can be used to drive an alternator, hydraulic pump, or direct mechanical force transfer system which will meet the pumping and systems requirements. The incorporation of ram air turbine assemblies is well documented within the aerial refueling industry and was also disclosed by Spotswood & Robinson, in **U.S. Patent 4905937**, issued on March 6, 1990, entitled "Pod Assembly With Integrated Radiofrequency Emitting And Aerial Refueling Equipment" which addressed a composite female refueling pod with vertical hose reel, an Electronics Counter Measures section, and ram air turbine for power. However, Spotswood & Robinson did not contemplate a temporary, roll on, Pressure Plug **31**, Installation which, is carried within an aircraft fuselage.

The present invention, also integrates within the Conformal Fairing **131**, a hose guillotine mechanism of conventional design, used within the refueling industry to cut or disconnect the Refueling Hose **135**, from the host aircraft in the event of an emergency.

<u>DROGUE STABILIZATION</u> - As further depicted in FIGs. 1 through 5, 13, 14, 15, 17, 18, 19, 20, and 22, the present invention also addresses the need for an enhanced a flyable, Drogue Stabilization Circular Foil **261**, and Drogue Stabilization Air Foil **262**, which can be steered to an Approaching Aircraft **22**, and provides; a) vertical and horizontal separation of two simultaneously deployed Drogue & Hose Assembly **260**, means, b) creates a flat section of Refueling Hose **135**, critical for helicopter refueling, c) steers the Drogue & Hose Assembly **260**, away from localized trailing vortices and turbulence pockets generated by the host aircraft, and d) stabilizes the Collapsible Drogue Basket **264**. It has been contemplated that an integrated drogue and stabilization airfoil could be combined into one unit, however this would result in the loss of the flat hose segment required for safe helicopter refueling, and would certainly cause damage to the receiving aircraft due to frequent bow wave induced vortices which result in contact with the drogue assembly. For practical and enabling design, all drogue manufacturers typical of West Coast Netting, of the United States, endeavor to minimize weight in the design of drogues and to keep metallic components to a minimum due to the consequences of uncontrolled aircraft contact and subsequent damage. Hence, the aforementioned desired characteristics are achieved by a plurality of Drogue Stabilization Air Foil **262**, means to provide increased directional stability and dynamic, flyable control of the Collapsible Drogue Basket **264**. The Drogue Stabilization Air Foil **262**, serves as a mounting surface for the actuated Drogue Stabilization Air Foil Trim Tab **263**, means attached to the trailing edge of the Drogue Stabilization Air Foil **262**, means which act like aircraft flight control surfaces to effect roll, pitch, and yaw moments of the Drogue Stabilization Air Foil **262**, assembly. Said Drogue Stabilization Air Foil Trim Tab **263**, means can be controlled by the system operator by means of a Radio Frequency Remote Control Unit **269**, with built in batteries of conventional design trickle charged by means of solar photovoltaic cells also of conventional design embedded in the upper surface of the Circular Air Foil **261**. Control of the Circular Air Foil **261**, Drogue Stabilization Air Foil Trim Tab **263**, means may also be achieved by a Hose Data And Electrical Cable **270**, integrated within the Refueling Hose **135**. In either wireless or hard wired control methodologies, small electro mechanical servo's typical of those used and manufactured by Teledyne Ryan of San Diego in the *micro unmanned aerial*

vehicle "MALD" being built for the U.S. Air Force are actuated by the system operator, by means of the System Interface Assembly **280**.

Further, although Krispin & Velger disclose in **U.S. Patent 5326052**, issued on July 5, 1994, entitled "Controllable Hose-And-Drogue In-Flight Refueling System", they do not address portability, particularly in a roll on installation, and further base the design on a gas pressurization and thruster arrangement to maneuver the drogue. The methodology described by Krispin and Velger is complex, requiring the incorporation of a charged gas system. Further, the integration of the flyable components on the drogue does not create a segment of flat hose line, which facilitates helicopter refueling. By contrast as depicted in FIGs. 1 and 2 the present invention separates the Drogue Stabilization Circular Air Foil **261**, from the Collapsible Drogue Basket **264**, and thereby creates the required section of flat Refueling Hose **135**, to keep helicopter rotors away from the Refueling Hose **135**. The separation of said Drogue Stabilization Circular Air Foil **261**, from the Collapsible Drogue Basket **264**, is achieved by forward velocity of the aircraft inducing aft moving air which exerts a pulling force on the Collapsible Drogue Basket **264**, away from the Conformal Fairing **131**, as the Airborne Fuel Pumping Module **70**, releases the Refueling Hose **135**, until a low profile Male Hose lock **267**, integrated at a preset length of Refueling Hose **135**, interfaces with a Female Hose lock **268**, affixed to the leading edge of the Drogue Stabilization Circular Air Foil **261**. When the refueling Hose **135**, is retracted, once the Drogue Stabilization Circular Air Foil **261**, is stowed within the Conformal Fairing **131**, the locking mechanism passively disengages to allow retraction of the remaining Refueling Hose **135**, segment. The design also incorporates a plurality of small flexible, axially arrayed Drogue Anti Spin Foils **265**, oriented around the Refueling Hose **135**, adjacent to the Collapsible Drogue Basket **264**, to inhibit spinning of the drogue. Said Drogue Anti Spin Foils **265**, are intended to be preset at given incidence angles to prevent spinning of the drogue around the bell housing.

ARTICULATED BOOM – As depicted in FIG. 21, a first Lockheed-Martin C-130 Aircraft **2**, is equipped with a Conformal Fairing **131**, and an interoperable NATO and U.S. Air Force standards, Articulated Boom Assembly **110**, engaged in male probe to female receptacle refueling of a second Lockheed-Martin C-130 Aircraft **2**. The Boeing Corporation currently manufactures, an articulated boom

assembly for USAF probe based refueling, applications which can provide an adapter for hose and drogue refueling but as yet no, combined notion for simultaneous integration of both male and female capabilities with full extension and retraction capabilities exists. Further, As depicted in FIG. 22 the preferred embodiment of the present invention solves the problem of non dedicated, roll on roll off, interoperability and depicts refueling of a Lockheed-Martin C-130 Aircraft **2**, refueling a Sikorsky H-60 Jayhawk **11**, helicopter equipped with a portable External Tank And Male Probe Assembly **21**, is equipped with a Laser Reflective RF Tag **196**, to effect non dedicated localized aircraft position referencing, using a NATO based female refueling system standard. Said Articulated Boom Assembly **110**, being of conventional U.S. Air Force compatible boom refueling designs manufactured by the Boeing Corporation of Washington, USA. A pod based male probe articulated refueling system is disclosed on behalf of the Boeing Corporation by Higgs et.al, in **U.S. Patent 5996939**, issued Dec. 7, 1999, entitled "Aerial refueling boom with translating pivot" wherein a ram air turbine for power, and articulated male refueling boom are attached to bottom of a given aircraft in a pod with mounting, pumping, and fuel transfer systems transiting through a modified fuselage. The system disclosed by Higgs et. al. is not roll on, non-dedicated, or NATO/USAF interoperable without ground based installation, and requires considerable modification to the host airframe.

Although it is common practice to integrate a Collapsible Drogue Basket **264**, in place of a Male Refueling Probe **114**, on an articulated boom assembly as has been demonstrated by various air forces on Boeing tankers, and other aircraft, a combined dual NATO and USAF standards, interoperable, Male Refueling Probe **114**, and Collapsible Drogue Basket **264**, integrated into one assembly which can deploy either male or female capability from the same Articulated Boom Assembly **110**, within a minute of using either standard, without landing the aircraft to exchange fuel interface devices, has not been previously undertaken and is part of the preferred embodiment of the present invention as depicted in FIGs. 21 and 22.

Further the present invention utilizes common practices for articulating, extending, and retracting, the Articulated Boom Assembly **110**, which comprises a Boom Multi Axis Joint Assembly **111**, which passes from the interior of the aircraft to the exterior of the aircraft by means of a Pressurized Plug **31**, and employs

mechanical actuation and joint systems typical of those disclosed by Ruzicka, on behalf of the Boeing Corporation, in U.S. Pat nt 5785276, issued on July 28, 1998, entitled; "Actuated Roll Axis Aerial Refueling Boom", wherein the boom joint and mounting assembly permits motion about three axis of movement, or alternatively in a two axis system Kerker, U.S. Patent 4586683, issued on May 6, 1986, entitled "Rolling aerial refueling boom" which achieves two axis of boom motion. Further, as depicted in FIGs. 5 and 6, said Articulated Boom Assembly **110**, transfers static system loads and dynamic flight loading to a Mounting Pallet **33**, assembly by means of a Cantilever & Flutter Isolation Armature **174**, which passes through the Pressurized Plug **31**, and has a can utilize a Counterweight **175**, for heavier loads which require internal compensation for outboard weight as illustrated in the Refueling Probe Receiving Assembly **170**, depicted in FIG. 4, affixed to the Mounting Pallet **33**, on a plurality of Vibration Damper **37**, means to isolate said vibration and dynamic loads. The preferred embodiment of the current invention can accommodate simultaneous deployment of two Articulated Boom Assembly **110**, systems from the same aircraft using removable Pressurized Plug **31**, means on both sides of the aircraft fuselage thereby meeting the requirement of refueling system redundancy in the event that one system becomes inoperable, particularly in open ocean missions.

Further, in FIGs. 21 and 22, said Articulated Boom Assembly **110**, has extension and retraction capabilities which permit said Articulated Boom Assembly **110**, to be retracted and stowed for transit when not in use and extended when engaged in the process of refueling comparable to existing systems and methodologies employed aboard Boeing USAF standard KC-135 aircraft and McDonnell Douglas KC-10 aircraft. Said extension and retraction capability being achieved from mechanical actuation, fuel, hydraulic, or pneumatic pressure means common to those skilled in the art of refueling and landing gear actuation, and comprising a Boom 1st Stage Housing **112**, which provides a cavity large enough to house a telescopic Boom 2nd Stage Housing **113**, which provides a cavity large enough to house a telescopic Male Refueling Probe **114**, which is equipped with a Boom Air Foil Stabilization Assembly **115**, typical of systems disclosed by Anderson et.al., **U.S. Patent 4095761**, issued on June 20, 1978, entitled "Aerial Refueling Spoiler", and Ishimitsu & Tinoco, **U.S. Patent 4231536**, issued on

Nov. 4, 1980, entitled "Airfoil For Controlling Refueling Boom" to stabilize and provide dynamic control of the boom throughout its full range of motion in flight.

Further, as depicted in FIG 21, said Articulated Boom Assembly **110**, also provides a mounting surface for a Video Laser Housing **203**, denoting Video Field Of view **201**, and other lighting assemblies required for indication and illumination during refueling operations.

In the preferred embodiment of the present invention, the combined Articulated Boom Assembly **110**, integrates a Male Refueling Probe **114**, comparable to that disclosed by Oliver et.al., **U.S. Patent 5092194**, issued on March 3, 1992, entitled "Deployment Arrangement" of a collapsible or retractable male *refueling* probe, which in the present invention is located on the upper side of the Boom 2[nd] Stage Housing **113**, and incorporates the Collapsible Drogue Basket **264**, on the lower side of the Boom 2[nd] Stage Housing **113**, as to effect deployment of either *male* or *female* fuel transfer systems without interfering with the other due to aerodynamic forces exerted on said Articulated Boom Assembly **110**, in flight. The present invention also incorporates standard.

The present invention can also accommodate a composite solution on a Lockheed-Martin C-130 Aircraft **2**, or like aircraft with two side doors located on either side of the rear fuselage, wherein a non dedicated, roll on roll off, NATO compliant Conformal Refueling Assembly **130**, with female Collapsible Drogue Basket **264**, is mounted on the port side of the aircraft while an Articulated Boom Assembly **110**, with Male Refueling Probe **114**, is mounted on the starboard side of the aircraft.

REFUELING STRUTS - As depicted in FIGs. 5, 6, 17, 18 and 19, the preferred embodiment of the present invention also utilizes a multi-function, multi-mission, articulated strut assembly, which passes through a temporarily mounted Pressurized Plug **31**, in an aircraft fuselage, and effects articulation of a Fixed length strut **222**, or a Telescopic Articulated Strut **218**, wherein one variant depicted in FIGs. 5 and 19, integrates a Strut Refueling Fairing Assembly **150**, which is capable of articulating vertically in flight by means of two Vertical Actuator **216**, assemblies, to permit simultaneous refueling from both sides of the aircraft. Fixed length strut **222**, can also be a Telescopic Articulated Strut **218**, capable of extending in a telescopic fashion by mechanical actuation, fuel pressure, hydraulic

pressure, or pneumatic pressure, means, common to those familiar with the art of aircraft landing gear and strut assemblies to provide enhanced horizontal wing tip separation between two aircraft as denoted in FIG.s 17, and 19. When used in tandem on both sides of the aircraft, means comparable to the configuration and installation of the Articulated Boom Assembly **110**, are applicable to the Strut Refueling Fairing **150**, assembly which houses a female drogue, hose, and pulley, within said Strut Refueling Fairing **150**, and palletized hose, reel, pumping and low profile tank and cargo assembly inboard of the aircraft fuselage.

Said Strut Refueling Fairing **150**, assembly comprises a Strut 1st Stage Housing **213**, a Strut 2nd Stage Housing **214**, a Telescopic Articulated Strut **218**, and a Strut Refueling Fairing **150**, which can be stabilized at the outboard periphery by a JATO Compression Stabilizer Strut **217**, when mounted on a Lockheed-Martin C-130 Aircraft **2**, which is attached to the Jet Assisted Take Off or JATO Mounts **226**, mounts on the main gear fairings of the fuselage without incurring any airframe modifications as depicted in FIGs. 16, 17, and 18. Although the Able Corporation of the USA, has developed a similar strut and fairing concept employing a horizontal movement, piston actuation system and has disclosed same in **U.S. Patent 5573206**, filed by Ward issued on November 12, 1996, entitled; "Hose And Drogue Boom Refueling System, For Aircraft", the patent specifically indicates in the "Summary Of The Invention" that the invention requires fewer structural modifications, and in the "Detailed Description" of the Invention indicates the fuselage may bulge to accommodate features of the invention, further indicating airframe modifications. The preferred embodiment of the present invention uses a Fixed length strut **222**, or a Telescopic Articulated Strut **218**, which passes through a Pressure Plug **31**, assembly without incurring any airframe modifications, even on aircraft not equipped with rear loading methodologies comparable to a Boeing 767 aircraft, which still possesses cargo floor restraint systems which do not require a Mounting Pallet **33**, assembly.

The Strut Refueling Fairing **150**, assembly as installed on a Lockheed-Martin C-141 Starlifter **10**, is depicted in FIG 19 refueling a Lockheed-Martin C-130 Aircraft **2**, and an Augusta Westland EH-101 Cormorant Helicopter **5**, without any JATO Compression Stabilizer Strut **217**, means using a Telescopic Articulated Strut **218**, with a Strut Refueling Fairing **150**, which is equipped with a Drogue And Hose

Assembly **260**, depicting controlled separation of the aircraft for simultaneous refueling. FIG 19, also indicates an arc of movement to retract said Telescopic Articulated Strut **218**, rearward against the fuselage for higher speed transit when not engaged directly in refueling operations. Further, FIG. 16 also indicates retraction and extension movements of said Telescopic Articulated Strut **218**, assembly in a spray configuration as mounted through a pressure Plug **31**, and installed on a Lockheed-Martin C-130 Aircraft **2**.

Further as depicted in FIGs. 6, and 18, the present invention also permits removal of the Strut Refueling Fairing Assembly **150**, and elimination of all inboard fuselage pumping systems, to accommodate prepackaged, bolt on refueling pods typical of those manufactured by Sargent Fletcher, and Aero Union of the USA. A similar concept is disclosed by Moss et.al. in **U.S. Patent 5667170**, issued on September 16, 1997, entitled "Pod Mounted Refueling System" which discloses a pylon, and female hose and drogue refueling pod to mounted at the end of the pylon away from aircraft fuselage. However, Moss fails to disclose any form of portable mounting methodology, low profile fuel tanks, simultaneous cargo carrying capability, guidance system, or roll on methodology.

When a Refueling Pod **152**, means is used with a Telescopic Articulated Strut **218**, or a Fixed length strut **222**, the Strut Refueling Fairing **150**, is removed and said Refueling Pod **152**, comparable to the Aero Union 1080 pod, or Sargent Fletcher hose and female drogue refueling assembly is attached as depicted in FIG. 6, and in particular FIG 18, where a Lockheed-Martin C-130 Aircraft **2**, is engaged in refueling two, Northrop Grumman A-6E Prowler Approaching Aircraft **22**, using said Telescopic Articulated Strut **218**, and Refueling Pod **152**, assembly.

SPRAY SYSTEM – As depicted in FIGs. 9, 10, 14, and 16, the present invention also includes adaptation of the roll on Segmented Low Profile Tank **61**, assembly for use with a Spray Fluids Pumping Module **86**, and a Spray System Assembly **210**, to effect aerial spraying while the aircraft is pressurized. Said Spray System Assembly **210**, comprising at least one and preferably a plurality of Spray Nozzle **211**, means, with variable flow rate head adjustment, connected to Fluid Piping **71**, means to transfer the Spray Fluid **221**, contained within a single or multiple Segmented Low Profile Tank **61**, means, with flat upper surfaces for cargo carrying capabilities, or Conventional Fuel/Spray Tanks **225**, under pressure from a

Spray Fluids Pumping Module **86**, to a spray dispersal assembly mounted outboard of the aircraft.

The present invention as depicted in FIGs 9, 10, 14, and 16, relative to aerial spraying first addresses one of three pressurized door plug aerial spraying methodologies which all use common tank, pumping, pressurized plug mounting, and piping means for portable non dedicated spraying applications.

The first and preferred embodiment of the present invention as depicted in FIGs 9, 10, and 14, is of a Conformal Fairing **131**, which incorporates a simplified aerial spraying system for use while the aircraft is pressurized, or unpressurized. Said Conformal Fairing **131**, providing an aerodynamic, low drag, mounting surface for integrating Fluid Pipe **71**, means which are connected to a plurality of Corealis Effect Fluid Line Straighteners **233**, commonly used in fire hose and nozzle assemblies to provide a more concentrated, longer stream of fluid. Said Corealis Effect Fluid Line Straighteners **233**, are in turn connected to a Variable Nozzle Array **224**, oriented approximately 45 degrees aft and sideways from the aircraft fuselage such that the nozzles are sized smaller to larger from the leading edge to the trailing edge of the Variable Nozzle Array **224**, and that Fluid Line **71**, means are of various sizes going from larger diameter at the leading edge to smaller diameter towards the trailing edge of the Conformal Fairing **131**, as to effect a concentrated, straightened, controlled dispersal pattern which accommodates the forward motion of the aircraft, and ejects the Spray Fluid **221**, to point "X" just below, and aft of the horizontal tail stabilizer wing tip noted on FIG.10 to mix with the stabilizer wing tip Wake Vortices **303**, and also in like manner ejects the Spray Fluid **221**, to point "Y" downstream aft of the main wing tip noted on FIG.10 to mix with the main wing tip Wake Vortices **303**, of the aircraft. This fluid spraying methodology provides a means for achieving less drag, portable non-dedicated installation, and effects a more uniform and wider distribution of the Spray Fluid **221**, by means of the tail and wing tip Wake Vortices **303**. As depicted in FIG. 9, the preferred embodiment of the present invention may also use a single High Volume Nozzle Assembly **228**, an use a higher volume flow rate of Spray Fluid **221**, targeted at either point "X", or Point "Y", and still achieve acceptable mixing rates and dispersal patterns for even dispersal of the Spray Fluid **221**, within the trailing Wake Vortices **303**, of either the tail or main wing tips.

Further, said Spray Fluids Pumping Module **86**, or the individual Spray Nozzle **211**, assemblies may also be used to oscillate in rapid sequence the supply of Spray Fluid **221**, thereby providing intermittent pulses of said Spray Fluid **221**, and further gain a more even distribution once the Spray Fluid is injected into the high speed air stream of the aircraft. This method of oscillating pulses of water is common practice in household bathroom shower-head hardware, typical of those systems manufactured by the Teledyne Corporation of the USA.

As depicted in FIG 13 and 14, the present invention as it relates to the Conformal Fairing **131**, Spray System Assembly **210**, may also be mounted in tandem with other work systems, sensors, or power generation systems for self contained, augmented, or dual mission scenarios, including the integration of a retractable Gimbal Sensor **44**, or other sensor, a Conformal Refueling Assembly **130**, system, a Ram Air Turbine **231**, a Dry Particulate Dispersal Fairing **230**, or other systems disclosed herein to obtain combinations of capability obvious to those skilled in the art of integrated mission response systems.

Further as disclosed by Rameth, in **U.S. Patent 5320282**, issued on June 14, 1994, entitled; "Aerial Sprayer" or other fixed wing aircraft means typical of the system disclosed by Ryle, **U.S. Patent 4180224**, issued on December 25, 1979, entitled; "Aerial Dispersal System" which describes a plurality of trailing edge movable airfoils to disperse a fluid medium, or a novel way of integrating upper or lower control surfaces for agriculture-spraying biplanes as described by Wilson, **U.S. Patent 4278221**, issued on July 14, 1981, entitled; "Agriculture Spray Plane", all have described airframe modified, wing foil type of spray systems, which typically use the trailing edge of wing, or airfoil appendages mounted beneath a given wing assembly, or attached to the fuselage using various means of controlling fluid droplet size, which require airframe modifications. Further said spray systems or are not portable, and do not spray fluids into the trailing vortices of the host aircraft but rather seek through mounting, rails, multiple nozzles, spray orifices, and the like to achieve even dispersal of the fluid medium across the length of a given strut, boom, or airfoil assembly.

Further based upon more conventional methods of spraying as described by Rameth, Ryle, Wilson and others, several derivatives of the present invention are also disclosed which use more conventional spray methodologies but still embody

the preferred non-dedicated side door, pressurized mounting system for a common interchangeable portable pressure Plug **31**, and Spray System Assembly **210**, as disclosed and depicted in FIG. 16, wherein the present Invention may also incorporate a Strut 1st Stage Housing **213**, and an extended telescopic Strut 2nd Stage Housing **214**, through to the third and final Telescopic Articulated Strut **218**, assembly. Said Spray System Assembly **210**, strut means when employing telescopic extension and retraction capabilities, are actuated and extended laterally away from the side of the aircraft for example, the side of a Lockheed-Martin C-130 Aircraft **2**, by means of telescopic actuators common to those skilled in the art of aircraft flap and landing gear actuation systems. Said Spray System Assembly **210**, being actuated vertically by means of a Vertical Actuator **216**, and extended in the horizontal range of motion to retract said assembly aft for transit by a Horizontal Actuator **178**, means and otherwise stabilized against aerodynamic forces caused by forward flight on Lockheed-Martin C-130 Aircraft **2**, by means of a JATO Compression Stabilizer Strut **217**, affixed to the JATO mounts on said Lockheed-Martin C-130 Aircraft **2**. Said JATO Compression Stabilizer Strut **217**, may also employ means of mechanical actuation using a piston comparable to the aerial refueling methodology disclosed by Ward in **U.S. Patent 5573206**, issued on November 12, 1996, entitled; "Hose And Drogue Boom Refueling System, For Aircraft". However, the application clearly denoted here as part of the preferred embodiment of the present invention is for a temporarily mounted spray system which transits through a removable, Pressure Plug **31**, and not through some other form of modified fuselage panel.

Other variants of a spray strut assembly also include a Fixed Length Strut **222**, as depicted in FIGs. 5, and 6, adapted for spraying, and actuated vertically by a Vertical Actuator **216**, and stabilized against high speed wind by a JATO Compression Stabilizer Strut **217**. Said Fixed Length Strut **222**, adapted for spraying, transferring Spray Fluid **221**, through the internal portions of the strut assembly by means of Fluid Piping **71**, assembly and discharging them along the trailing edge of the Fixed Length Strut **222**, by means of a plurality of Spray Nozzle **221**, means.

Said Spray System Assembly **210**, flow rate, dispersal pattern, strut assembly extension, retraction, elevation, and lowering, being affected from the System

Interface Assembly **280**. Said Spray System Assembly **210**, as they may utilize a fixed or variable length telescopic spray strut assembly, may be terminated at the end of the Telescopic Articulated Strut **218**, or Fixed Length Strut **222**, assemblies by a fairing of conventional design comparable to fairings used for terminating wing tips on aircraft, which may or may not, also be equipped with a Whitcomb Winglet, or other aerodynamic empennage to control lift, to neutralize adverse vortices, or to induce vortices which augment the spread of the Spray Fluid **221**.

Further as depicted in FIGs. 1, 4, 10, 23, and 24, the present invention also addresses the requirement for a portable fluid spray & particulate Precision Dispersal Control System **240**, comprised of a GPS Antenna And Fairing **27**, which receives an RF based GPS Transmission **26**, from a GPS Satellite **25**, and displays said location data on an ATIMS Moving Map Display **242**, a Geographic Information System **243**, software engine, a forward cockpit Yoke Mounted Display **243**, a Bioremediation Ballistic Winds Sensor **52**, a special mission detection sensor **244**, comprised of an infra red sensor, hyperspectral sensor, microwave radiometer, or other specialized biological, chemical, or radiation sensor, a Digital Terrain Modeling Database **245**, a Computer **294**, and System Interface Assembly **280**, which effects precise location and release control of fluid or particulate matter dispersal over an authorized Spray Zone **246**, and discontinues when the aircraft approaches a GPS correlated No Spray Zone **247**, determined by said portable Computer **294**, which also permits operator override for manual control of the dispersal system. The Precision Dispersal Control System **240**, is now in partial use with GPS, a user interface, and electronic map display with the Youngstown, Ohio, U.S Air Force Reserve Command's 910th Airlift Wing which are using a Differential Global Positioning System (DGPS), capability combined with computerized maps and satellite imagery, to attain substantially better delivery accuracy. However the system employed by the 910th Airlift Wing is not designed to integrate and analyze dynamic weather, humidity, temperature, wind direction, or other specialized sensor inputs typical of a Bioremediation Ballistic Winds Sensor **52**, manufactured by Coherent Technologies of Colorado USA, or other mission specific sensors for in-situ dynamic flight response to mitigate, airborne chemical, biological, or radiation agents. Neither are existing systems designed to integrate with a roll on non dedicated, zero modification fluid or particulate dispersal system.

DRY PARTICULATE DISPERSAL - As depicted in FIGs. 11,12, and 16, the preferred embodiment of the present invention also includes adaptation of the roll on Segmented Low Profile Tank **61**, to a Dry Tank Assembly **90**, which relays said dry particulate matter using the Compressor And Pressurization System **69**, in conjunction with a Dry Auger PTO Module **91**, and Dry Auger Feed System **92**, located within the ducting assembly which is similar to methodologies described by Sellards in, **U.S. Patent 3559930**, Issued on Feb. 2, 1971, entitled; "Distribution Of Particulate Material" to move and otherwise deposit said dry particulate matter into a Dry Particulate Duct **93**, assembly which under pressure and with mechanical auger means common to those skilled in the art of farm implements, and crop dusting material handling systems, relays said particulate matter through the Strut 1st Stage Housing **213**, and the extended telescopic Strut 2nd Stage Housing **214**, through to the third and final Telescopic Articulated Strut **218**, assembly where it connects with, a Dry Particulate Dispersal Fairing **230**, which is interchangeable with the Strut Refueling Fairing **150**, affixed to the end of the Telescopic Articulated Strut **218**. Once the particulate matter has been relayed to the Dry Particulate Dispersal Fairing **230**, assembly, negative intake pressure is provided by a free turning Ram Air Turbine **231**, assembly, which receives mechanical energy from ram air derived from forward motion of the host aircraft, and is ingested through a Diffuser Air Intake Nacelle **238**, which turns the Ram Air Turbine **231**, assembly, at high speed and thereby creates a vacuum which draws the particulate matter through the Diffuser Dry Particulate Intake Vent **236**, into the Diffuser Air Intake Duct **235**, and into the Door/Pallet Mounted Hopper **97**, assembly. Althouse & Wilcock, **U.S. Patent 5671869**, Issued on Sept. 30, 1997, entitled; "Fiber Chaff Disseminator" which discloses a chaff side oriented chaff hopper, or comparable to

or directly into the Diffuser Ejection Assembly **234**, where the dry particulate matter is directed mechanically under forced air pressure and rotationally actuated mechanical vanes to a Diffuser Dispersal Exhaust Vent **232**, which is divided along its width by a plurality of variable spaced diffuser vanes which expand to form a wider intake aperture the further away from the Diffuser Dry Particulate Intake Vent **236**, the dry particulate matter must travel for the purpose of creating an even intake volume and consequent even dispersal pattern across the width of the Diffuser Dispersal Exhaust Vent **232**.

Further, as depicted in FIGs.11, and 12, the preferred embodiment of the present invention comprises a Dry Particulate Dispersal Fairing 230, assembly, which can be integrated as part of a single fixed position Conformal Fairing 131, attached to a Pressurized Plug 31, that does not require the Strut 1st Stage Housing 213, the extended telescopic Strut 2nd Stage Housing 214, or third Telescopic Articulated Strut 218, assemblies. Said alternate and low aerodynamically designed Conformal Fairing 131, mounted dry particulate dispersal system configuration is preferred over fixed length or telescopic, or actuated strut systems due to simplicity, reliability, and aerodynamic qualities while achieving comparable dispersal patterns.

GUIDANCE & PROXIMTY WARNING - As depicted in FIGs. 1, 2, 5, 15, 20, and 21, a portable ranging and positioning refueling proximity location system which can be affixed to the Articulated Boom Assembly 110, the Conformal Refueling Assembly 130, the Strut Refueling Fairing 150, or the Strut Refueling Pod 152. The operating methodology of said Refueling Proximity Location System 190, is graphically depicted in the figure sequence denoted in FIG. 1, where the sensor, lighting, transmitter, and positional components which integrate to provide the capability for said refueling proximity location system, and generally comprise a localized radio frequency directional beam emitted from an RF Direction Finder Transmitter 192, located on the Host Refueling Aircraft 23, which can guide said Approaching Aircraft 22, to the proximity of the Host Refueling Aircraft 23, which has derived accurate position coordinates from at least one, and preferably two or more Lighted GPS Transmitter and Antenna 193, assemblies, affixed to the boom, strut, fairing, hose or pod refueling systems which are temporarily mounted on the Host Refueling Aircraft 23, and, or from Pressurized Plug 31, mounted GPS Antenna And Fairing with inboard transceiver and processor assembly. Further, Once the Approaching Aircraft 22, is in the proximity of the Host Refueling Aircraft 23, localized sensors are able to scan, range and derive the exact three dimensional GPS location of the Approaching Aircraft 22, within a controlled cartesian space of relative parameters which are then referenced with known computer based, three dimensional, solid model or wire frame datasets of the Approaching Aircraft 22, the Host Refueling Aircraft 23, the Male Refueling Probe 114, and the Collapsible Drogue Basket 264, refueling appendages. Further said Approaching Aircraft 22, may also be equipped with a portable handheld, ye safe,

Laser Reflective RF Tag **196**, which is used in conjunction with a Laser Illuminator **195**, to provide a known reference point to calibrate said three dimensional solid model, if the pilot of Approaching Aircraft **22**, carries said hand held, Laser Reflective RF Tag **196**, which can be affixed to the front of the cockpit heads up display, or the inside part of the windshield with temporary fastening or adhesive means. The exact positions of these assemblies are then displayed on the System Interface Assembly **280**, housed within the Host Refueling Aircraft **23**.

Said accuracy and dataset referencing of the Approaching Aircraft **22**, in relation to the Host Refueling Aircraft **23**, is also enhanced by several sensors comprising at least one and preferable several, micro miniature, short range Radar Proximity Detection System **191**, means, typical of integrated radar/antenna chip sets manufactured by Time Domain of the USA which are used to provide all weather, general distance ranging information between the position of the Approaching Aircraft **22**, and the Host Refueling Aircraft **23**.

In the preferred embodiment of the present invention, said proximity and ranging sensor means also comprise a scanning, range gated, eye safe Laser Illuminator **195**, comparable to system manufactured by Cyberware of the USA, which can undertake multiple scans every second of the Approaching Aircraft **22**, to obtain dynamic, relative distance, relative position, speed, and exact attitude configuration of the Approaching Aircraft **22**, and relay this data to a Computer **294**, located on the Host Refueling Aircraft **23**, which interprets, and displays the data for the system operator to use, and based upon archival performance and engineering data, can determine if the Approaching Aircraft **22**, is within safe flight parameters for air to air refueling, and if not initiate either an automatic or operator controlled disconnect, or alter approach and speed of either aircraft accordingly if required. Support for the aforementioned refueling proximity location system, and methodology is substantiated in typical processing, archival data, and dynamic data fusion, routinely undertaken in simulators operated by the U.S. Air Force, which run on Intel processor based Windows NT platforms using simulation software from the Paradigm Corporation of the USA, which can effect real time simulated response to refueling operator and pilot control inputs.

The present invention also addresses visual cues under VFR flight conditions wherein the preferred embodiment of the present invention comprises Indicator

Lights **197**, consisting of red, yellow, and green to provide the pilot of an Approaching Aircraft **22**, with Night Vision Goggle (NVG) compatible shape and color indicators which can be interpreted by the pilot under NVG situations. Said visual cues also incorporate either visible light or infra red activated broad area illumination for standard visible light, or NVG/IR filtered video use, under covert, or nighttime conditions without disclosure using an Infra Red/Visible Spot Light **200**, affixed to the temporarily mounted boom, strut, or fairing, components.

Further the present invention also recognizes and solves the problem of maintaining visual contact between the system operator on the Host Refueling Aircraft **23**, and the Approaching Aircraft **22**, by means of a plurality of LLTV/ALLTV Video Camera **199**, means, which are affixed to the temporarily mounted boom, fairing, stabilizing downrigger, drogue basket, strut or pod components and displayed at the System Interface Assembly **280**.

Further, the Conformal Refueling Assembly **130**, as depicted in FIG. 20, installed aboard a McDonnell Douglas C-17 **12**, aircraft engaged in refueling a Sikorsky H-60 Jayhawk **11**, helicopter equipped with a portable External Tank And Male Probe Assembly **21**, typical of those proposed by Garcia et.al. in **U.S. Patent 5810292**, issued on September 22, 1998, entitled "Aerial Refueling System With Telescoping Refueling Probe" on behalf of the Sargent Fletcher Corporation of California, may be equipped with a modified Garcia et. al "Aerial Refueling Tank System (ARTS)" External Tank And Male Probe Assembly **21**, which is equipped with a Laser Reflective RF Tag **196**, to effect non dedicated localized aircraft position referencing without installing the system on said Sikorsky H-60 Jayhawk **11**, helicopter.

SYSTEM INTERFACE - FIG. 23 - Is a perspective view of a non-dedicated, combined sensor, spraying, refueling, or dry particulate dispersal system, seat mounted, operator control station which houses a plurality of components and interface devices, collectively referred to as the System Interface Assembly **280**. The chair and pallet assembly are disposed within the airframe of the host aircraft and serve as the operator's control platform for controlling the temporarily mounted sensors, spraying, refueling and other components related thereto. The operator or observer sits in the Operator Chair **281**, which is slidably connected to Operator Chair Rails **296**. The Operator Chair Rails **296** effect forward and aft motion of the

chair assembly and are in turn fastened to a Mounting Pallet **33**. Mounting Pallet **33** can be moveably positioned and fixed to the aircraft floor using methods known in the art of pallet loaded aircraft, as disclosed in the aforementioned copending. U.S. Patent Application Serial No. 08/731,684. The purpose of the placement as shown and described is to provide for optimum ease of operation and ergonomically sound layout for a variety of users. Person's skilled in the art of aircraft mounted control systems will recognize the advantages of each of the components described herein, both in their presence as well as their placement. In general, the components described herein permit an operator to have joystick control and keyboard (i.e., computer keyboard) interface control while at the point of observation and control of the refueling, spray, or particulate diffuser system and related components.

Said System Interface Assembly **280**, comprising a Removable User Interface Assembly **284**, which is typically mounted in temporary fashion, to the Operator chair **281**, by means of an arm rest interface slip mount, which slides over both Armrest **297**, mean s, without modifying said Operator Chair **281**. Said Operator Chair **281**, and connected System Interface Assembly **280**, is oriented outward in a manner which is disposed to look through a Bubble Observation Panel **282**, mounted within the Pressurized Plug **31**, for the purpose of visually monitoring refueling events under day and night conditions using night vision goggles. Said Operator Chair **281**, is preferably attached to the mounting pallet **33**, to take advantage of the Bubble Observation Panel **282**, however, said Removable User Interface Assembly **284**, can be affixed to any crew chair within the aircraft for remote location control and operation of the temporarily mounted sensors, spraying, refueling and other work assemblies. Said System Interface Assembly **280**, comprises a High Resolution Ruggedized LCD **290**, for display of video, sensor, and system control attributes. When the operator so desires the High Resolution Ruggedized LCD **290**, can been closed, to permit the system operator to use the backside of the said High Resolution Ruggedized LCD **290**, to write on or for manned observation using an integrated removable Foam Leaning Bar **285**, which is attached to the back of the High Resolution Ruggedized LCD **290**, to permit the system operator, or search and rescue observer to lean forward and look through the Bubble Observation Panel **282**, or to permit greater access and to undertake other control functions at, for example, a navigator's station. Said

Removable User interface Assembly **284**, incorporates a variety of tactile user interface devices including a Pointing Stylus **287**, a Trackball **288**, a Keyboard **289**, a pair of Foam Wrist Pads **291**, disposed on both sides of the tray assembly, and extending off the periphery in the direction of the operator, to reduce impact and stress on the operator's wrists, and a Joystick **292**, which can be installed for left or right hand operation. The preferred embodiment of the present design is hard wire connected to a Computer **294**, connected to the various sensors, work systems, positioning and guidance systems, aircraft power, and 1552 data bus using a Data And Power cable **298**, means. Said Computer **294**, can use Unix, or Windows NT, operating systems, and can be adapted to use a variety of ruggedized, high speed or proprietary computer processors. Interface with said computer processing and visual data functions, is principally by means of a variety of software control interfaces, which are actuated by the aforementioned interface devices. However, the present invention can also include a plurality of tactile switches for electro mechanically initiated functions of the various systems.

While preferred embodiments have been shown and described, various substitutions and modifications may be made without departing from the spirit and scope of the invention. Accordingly it is to be understood that the present invention has been described by way of illustration and not limitation.

Aircraft & Miscellaneous
Lockheed-Martin C-130 Aircraft 2,
Augusta Westland EH101 Cormorant Helicopter 5,
Lockheed-Martin C-141 Starlifter 10,
Sikorsky H-60 Jayhawk 11,
McDonnell Douglas C-17 12,
M-2 Marine Rescue Vehicle 13,
Medvac Container 14,
Sensor Pod Assembly 18,
External Fuel Tank And Male Probe Assembly 21,
Approaching Aircraft 22,
Marine Rescue Vehicle Telemetry 24,
GPS Satellite 25,
GPS Transmission 26,
GPS Antenna And Fairing 27,

Mounting & Interface Assemblies
Pressurized Plug 31,
Mounting Pallet 33,
A/A32H-4A Cargo Handling System 34,
Vibration Damper 37,
Side Door Articulated Sensor Strut 43,
Gimbal Sensor 44,
Cargo Bearings 49,
JATO Telescopic Sensor Fairing Assembly 51,
Bioremediation Ballistic Winds Sensor 52,
Pressure Vessel 53,
Door Plug Mounting Bracket 54,
Door Plug Swivel Hinge 55,

Flat Top Tank Assembly
Segmented Low Profile Tank 61,
Ballistic Lining 62,
Fire Proof Lining 63,
Structural Housing 64,
Sump 65,
Removable Tank Baffles 66,
Bladder Tank 68,
Compressor And Pressurization System 69,
Airborne Fuel Pumping Module 70,
Fluid Piping 71,
Tank Lid 76,
Sump Taper 80,
Spray Fluids Pumping Module 86,
Compressed Air/Inert Gas Lines 87,

Dry Tank Assembly 90
Dry Auger PTO Module 91,
Dry Auger Feed System 92,
Dry Particulate Duct 93,
Auger Assembly 94,
Contoured Dry Tank Liner 95,
Pipe Connection Outlet 96,
Door/Pallet Mounted Hopper 97,

Articulated Boom Assembly 110,
Boom Multi Axis Joint Assembly 111,
Boom 1^{st} Stage Housing 112,
Boom 2^{nd} Stage Housing 113,
Male Refueling Probe 114,
Boom Air Foil Stabilization Assembly 115,

Conformal Refueling Assembly 130,
Conformal Fairing 131,
Hose Reel Assembly 133,
Refueling Hose 135,
Strut Refueling Fairing 150,
Refueling pod 152,
Refueling Pod Mounting Cradle 153,

Refueling Probe Receiving Assembly 170
Cantilever & Flutter Isolation Armature 174,
Counterweight 175,
Probe Fuel Pipe 176,
Cantilever Support 177,
Horizontal Actuator 178,
Pulley 179,
Female Fuel Receiving Receptacle 180,

Refueling Proximity Location System,
Radar Proximity Detection System 191,
RF Direction Finder Transmitter 192,
Lighted GPS Transmitter And Antenna 193,
Laser Illuminator 195,
Laser Reflective RF Tag 196,
Indicator Lights 197,
LLTV/ALLTV Video Camera 199,
Infra Red/Visible Spot Light 200,
Video Field Of View 201,
Radar Detection Field Of View 202,
Video/Laser Housing 203,
RF Direction Finder Transmission 204,

Spray System Assembly 210
Spray Nozzle 211,
Strut 1^{st} Stage Housing 213,
Strut 2^{nd} Stage Housing 214,
Vertical Actuator 216,
JATO Compression Stabilizer Strut 217,
Telescopic Articulated Strut 218,
Spray Fluid 221,
Fixed Length Strut 222,
Variable Nozzle Array 224,
Conventional Fuel/Spray Tanks 225,
JATO Mount 226,
Wake Vortices 227,
High Volume Nozzle Assembly 228,
Corealis Effect Fluid Line Straightener 233,

Dry Particulate Dispersal Fairing 230
Ram Air Turbine 231,
Diffuser Dispersal Exhaust Vent 232,
Diffuser Ejection Assembly 234,
Diffuser Dry Particulate Intake Vent 236,
Particulate Matter 237,
Diffuser Air Intake Nacelle 238,

Precision Dispersal Control System 240,
ATIMS Moving Map Display 242,
Geographic Information System 243,
Yoke Mounted Display 243,
Digital Terrain Modeling Database 245,
Spray Zone 246,
No Spray Zone 247,

Drogue & Hose Assembly 260
Flyable Drogue Stabilization Circular Foil 261,
Drogue Stabilization Air Foil 262,
Drogue Stabilization Air Foil Trim Tab 263,
Collapsible Drogue Basket 264,
Drogue Anti Spin Surfaces 265,
Male Hose lock 267
Female Hose lock 268,
Radio Frequency Remote Control Unit 269,
Hose Data And Electrical Cable 270,

System Interface Assembly 280
Operator Seat 281,
Bubble Observation Panel 282,
Removable User Interface Assembly 284,
Foam Leaning Bar 285,
Pointing Stylus 287,
Trackball 288,
Keyboard 289,
High Resolution Ruggedized LCD 290,
Foam Wrist Pads 291,
Joystick 292,
Computer 294,
Operator Chair Rails 296
Armrest 297,
Data And Power Cable 298,

I claim:

1. A roll on - roll off, portable aerial spraying, particulate dispersal, and refueling systems apparatus.

2. The apparatus according to claim 1 comprising a temporarily mounted, pressurized, roll on roll off, door, panel, or hatch mounted low profile, closed system pressurize, conformal fairing with a flight controllable, female drogue, hose, reel, drogue stabilization system, and guidance positioning assembly such that it does not affect aircraft pressurization.

3. The apparatus according to claim 1 comprising a temporarily mounted, pressurized, roll on roll off, door, panel, or hatch mounted fairing, with articulated, multi axis, telescopic boom, with male and female refueling probe and collapsible drogue and hose assembly, with stabilizing aerodynamic control surfaces to maintain and otherwise remotely trim the position of the refueling boom and drogue assembly.

4. The apparatus according to claim 1 comprising a temporarily mounted, pressurized, roll on roll off, side door mounted articulated fixed mount or telescopic strut or fairing, with multi function capabilities to accommodate a low drag refueling fairing, a refueling pod assembly, a spray assembly, and a dry chemical particulate diffuser assembly.

5. The apparatus according to claim 1 comprising a temporarily mounted, segmented, interconnected, roll on roll off, fire proof, bullet proof, explosion resistant, structurally reinforced, internally baffled, low profile fluid reservoir tank assembly capable of accommodating fuel, chemicals, bioremediation agents, or other liquids, in conjunction with heavy cargo, or passengers on the upper side of said temporary tank assembly.

6. The apparatus according to claim 1 comprising a temporarily mounted, segmented, interconnected, roll on roll

off, internally tapered, dry reservoir tank assembly with a pressurization system, and an auger dry particulate feed assembly which can simultaneously accommodate heavy cargo, or passengers on the upper side of said installed temporary tank assembly.

7. The apparatus according to claim 1 comprising a temporarily mounted, pressurized roll on roll off, ram air actuated, low profile, hydraulic, or electrically driven support capability for spraying, refueling, and dry chemical dispersal assembly.

8. The apparatus according to claim 1 comprising a temporarily mounted, portable GPS system used in conjunction with refueling, spraying, and particulate dispersal systems.

9. The apparatus according to claim 1 comprising a temporarily mounted, pressurized door, hatch, or removable panel with the capability of accommodating an operator's seat, a large flat, or protruding observer bubble window, which is used in conjunction with, and for the purpose of observing the, refueling, spraying, and particulate dispersal systems when deployed in flight.

10. The apparatus according to claim 1 comprising a temporarily mounted, portable user interface system used in conjunction with an infra red, and video monitoring system, or other imaging sensor, and refueling, spraying, and particulate dispersal systems.

11. The apparatus according to claim 1 comprising a temporarily mounted, portable Low Light Television (LLTV) and eyesafe laser ranging system with micro miniature range detecting radar chips and infra red proximity lighting system attached to an articulated male refueling probe or a female drogue basket and hose assembly which is used in conjunction with refueling systems to determine the proximity of the receiving aircraft to the refueling delivery assembly.

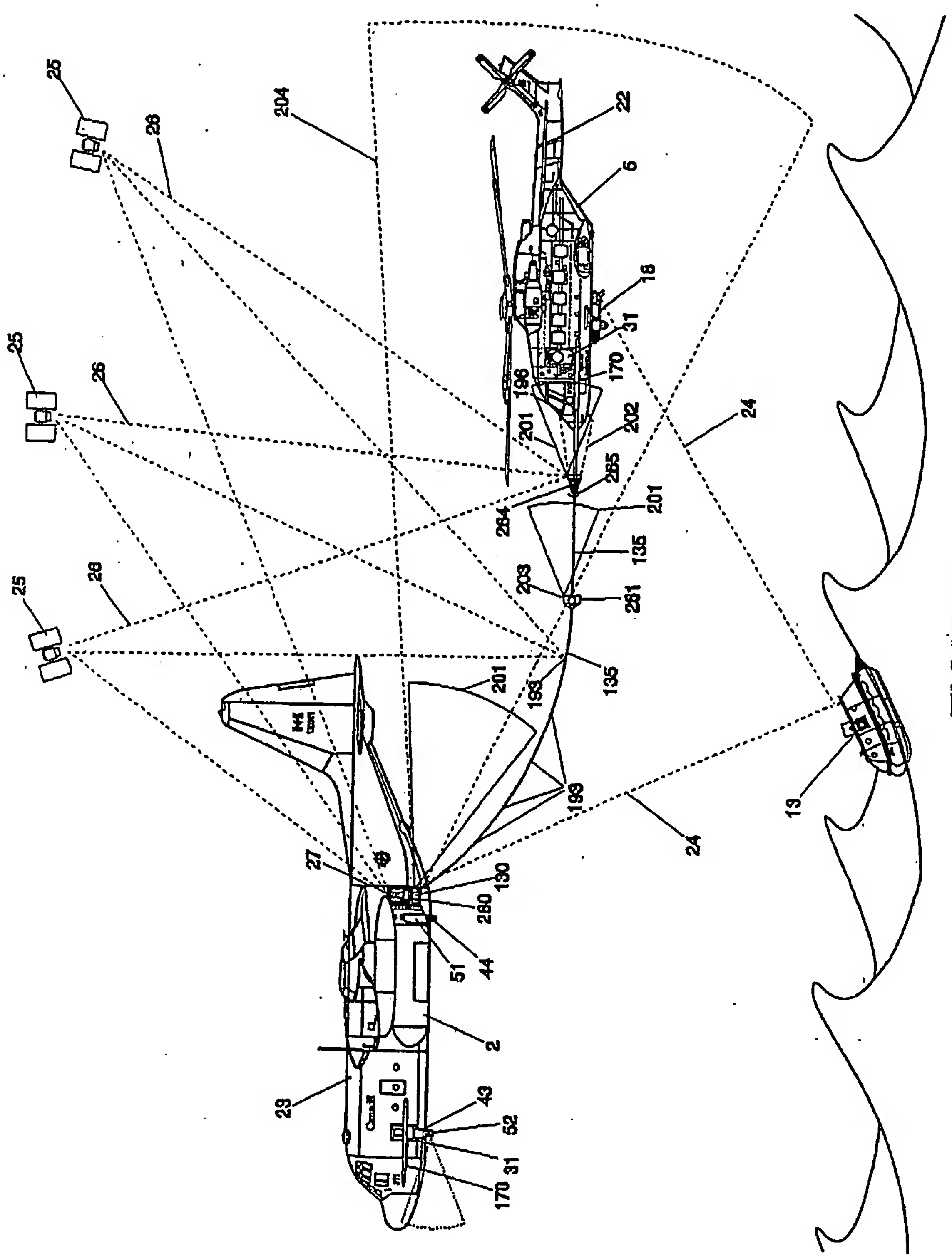
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FIGURE 1

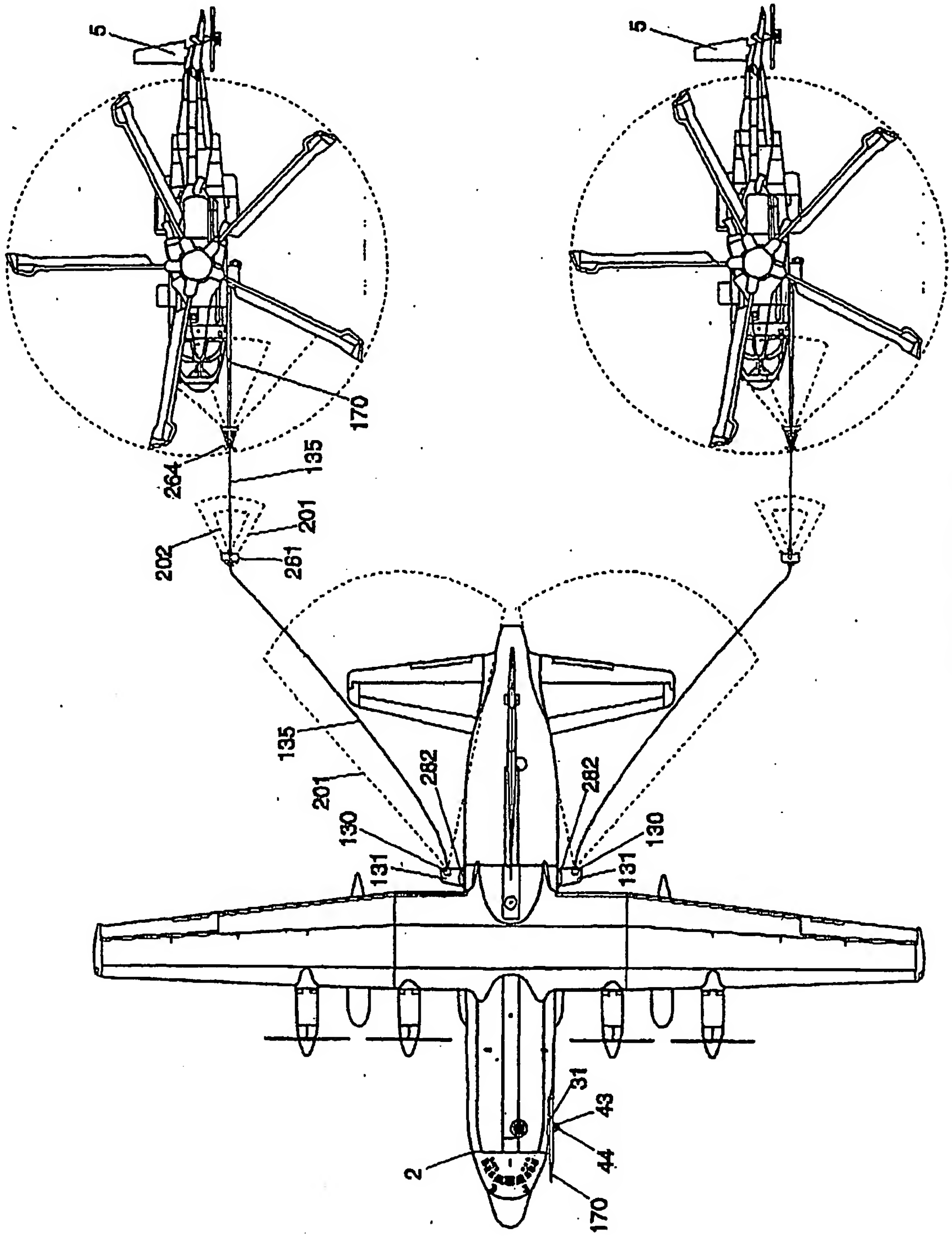
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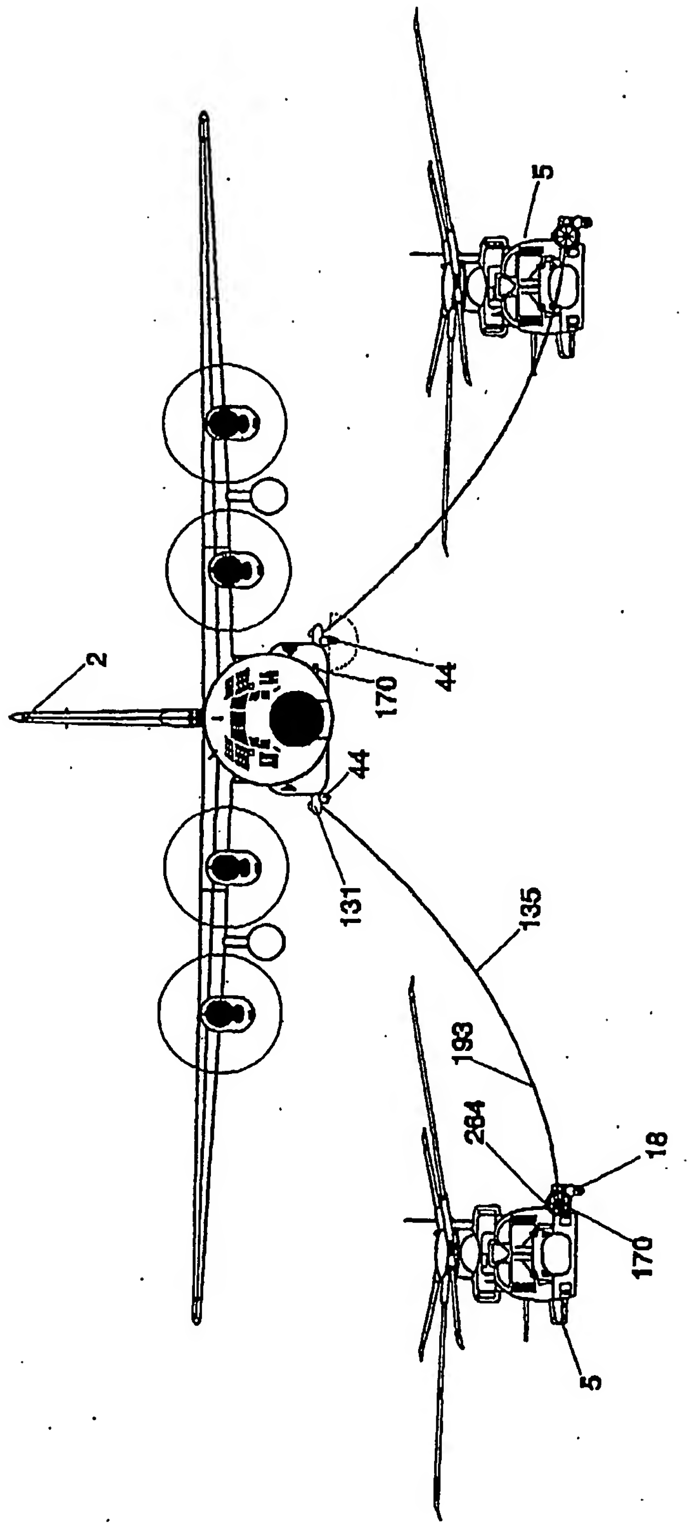
FIGURE 2



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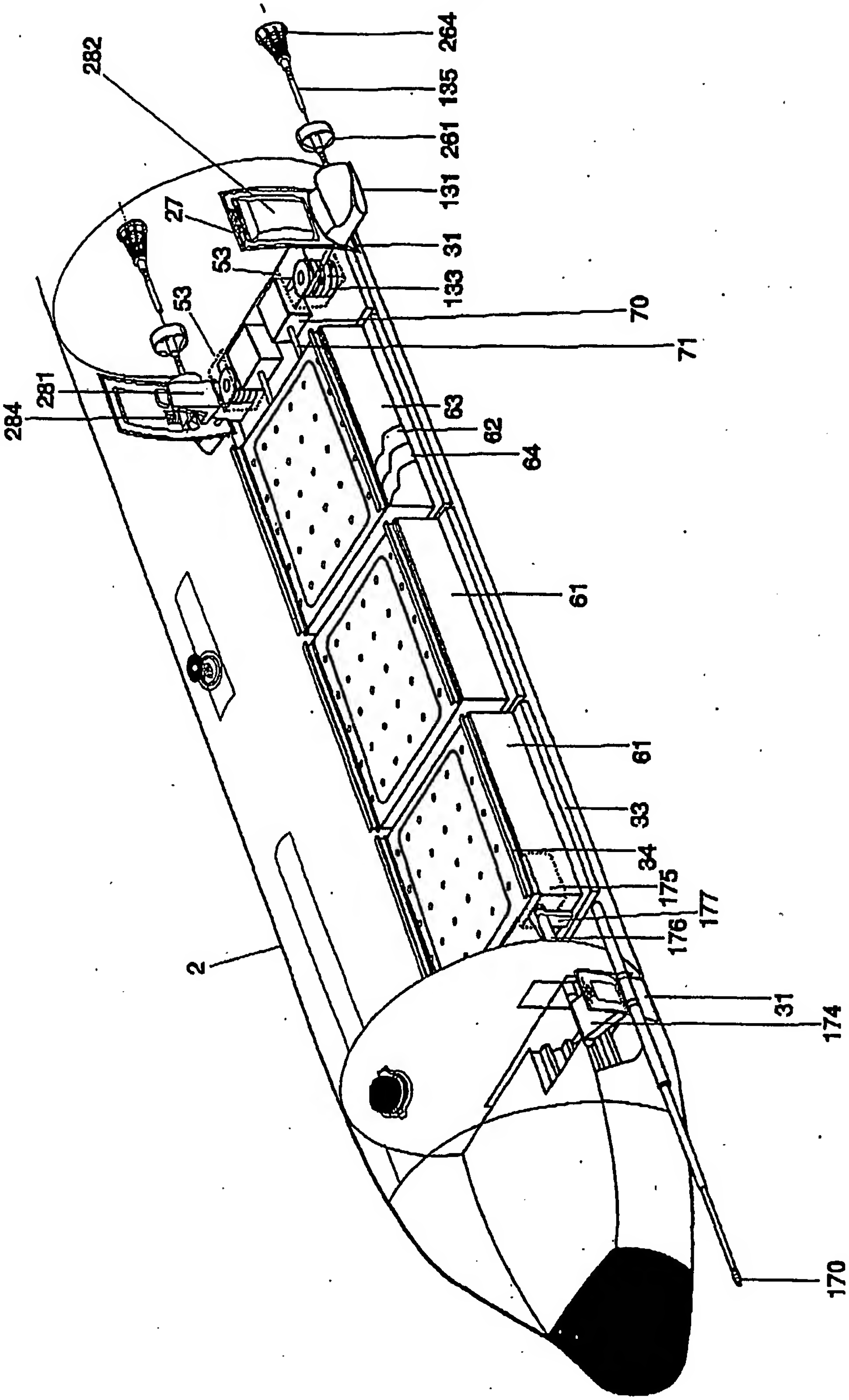
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FIGURE 4

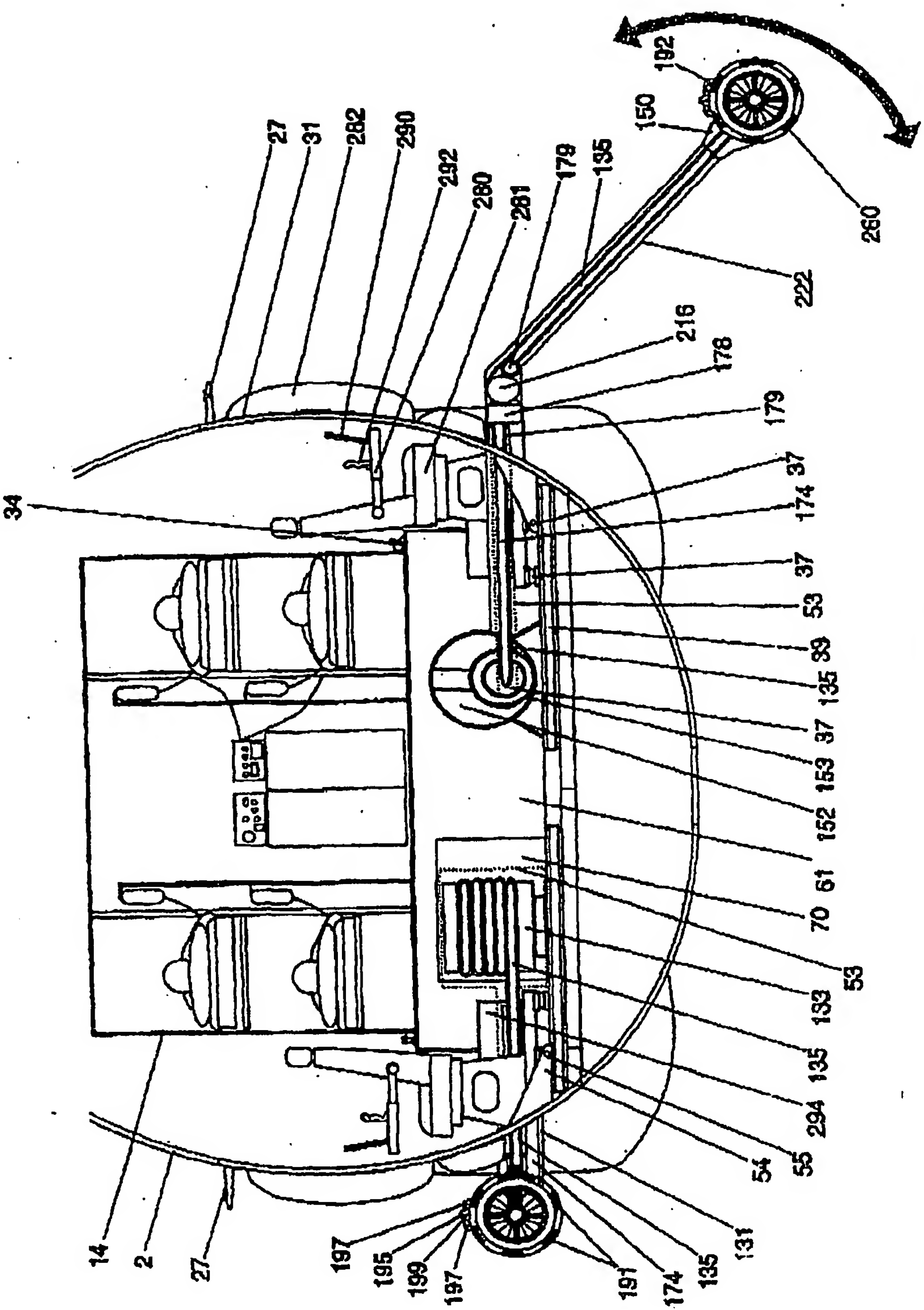
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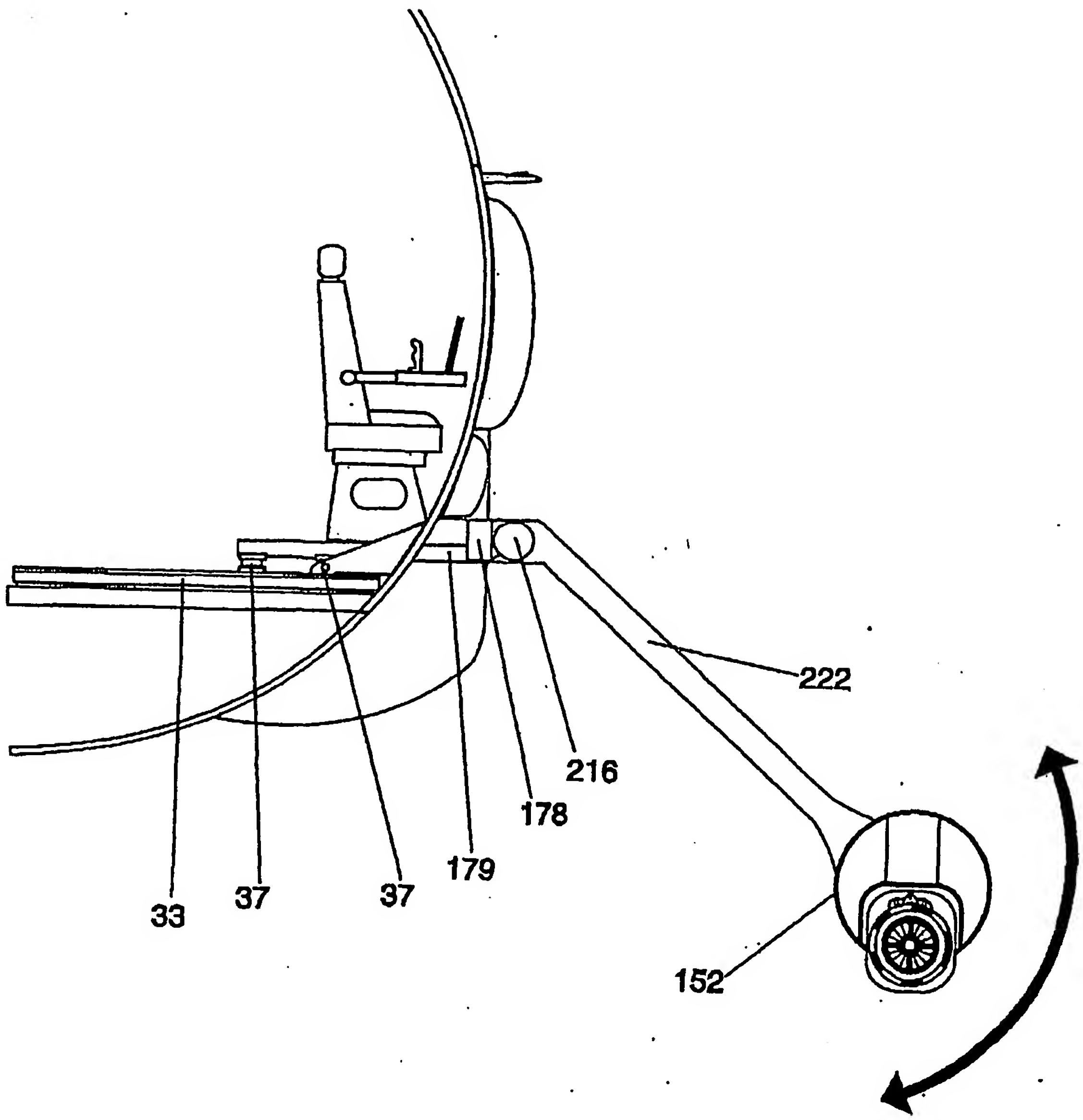
FIGURE 5



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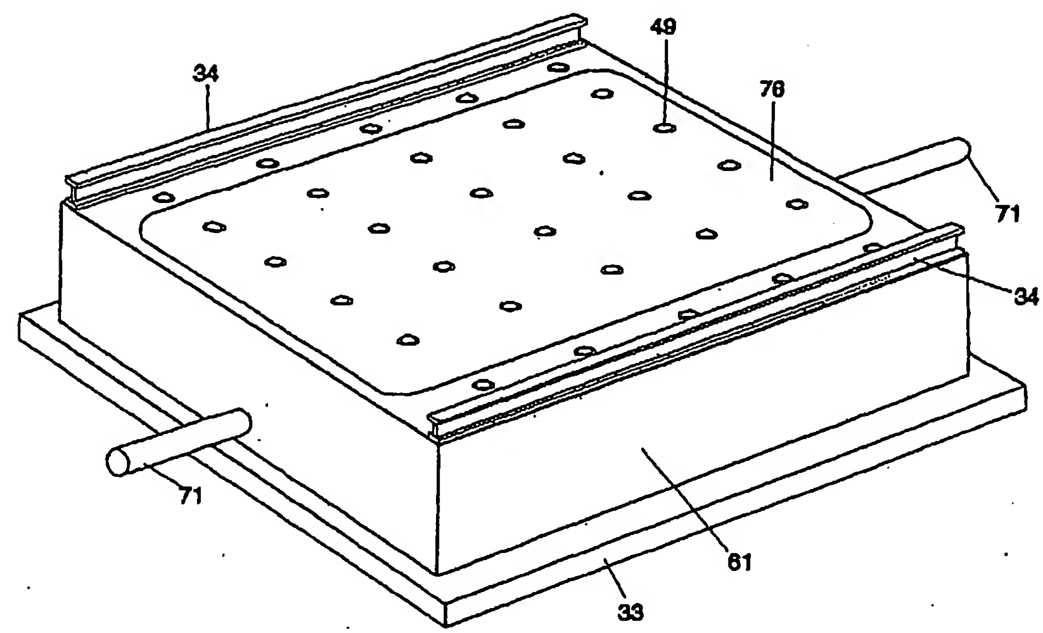

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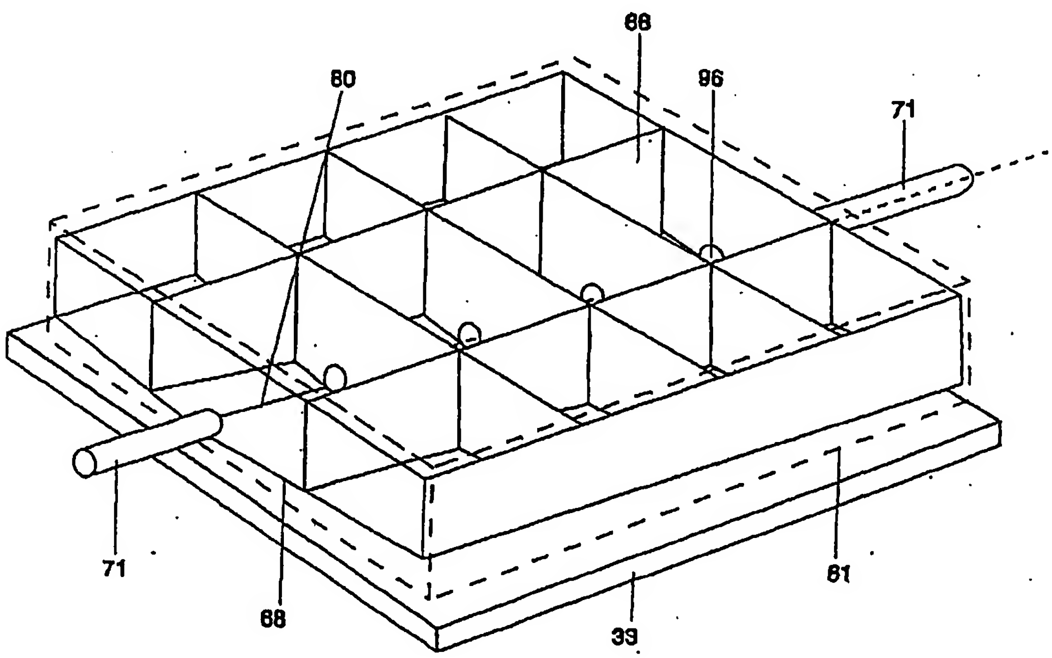

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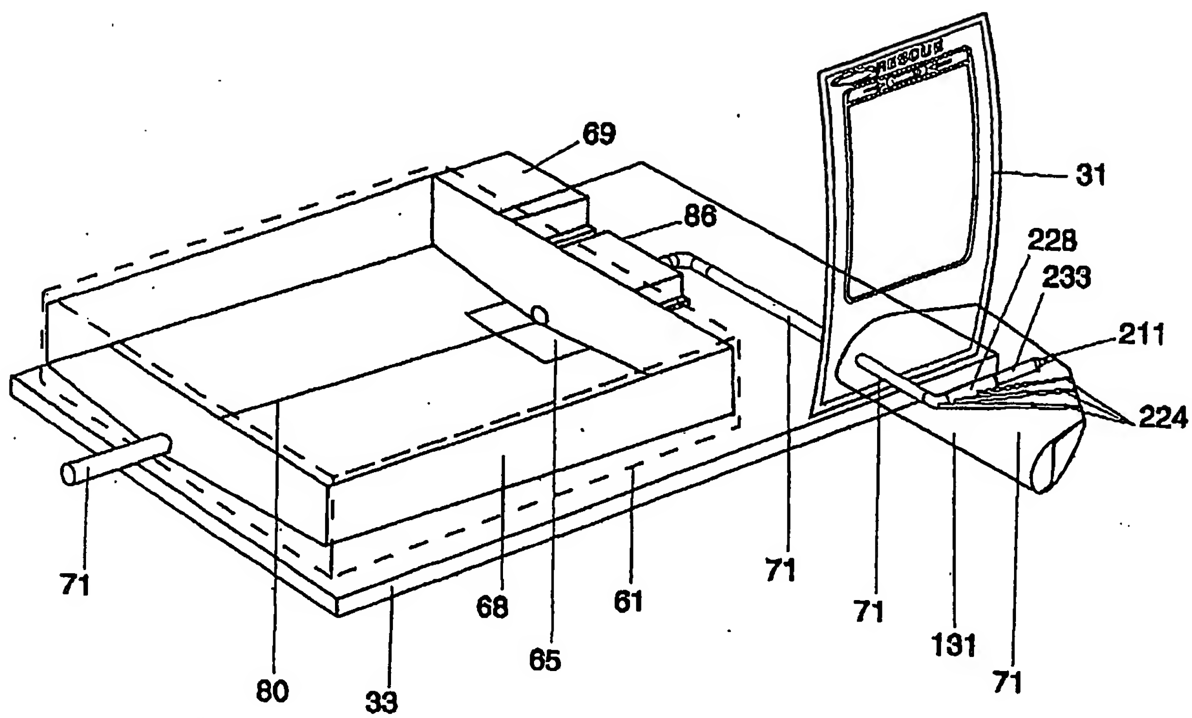
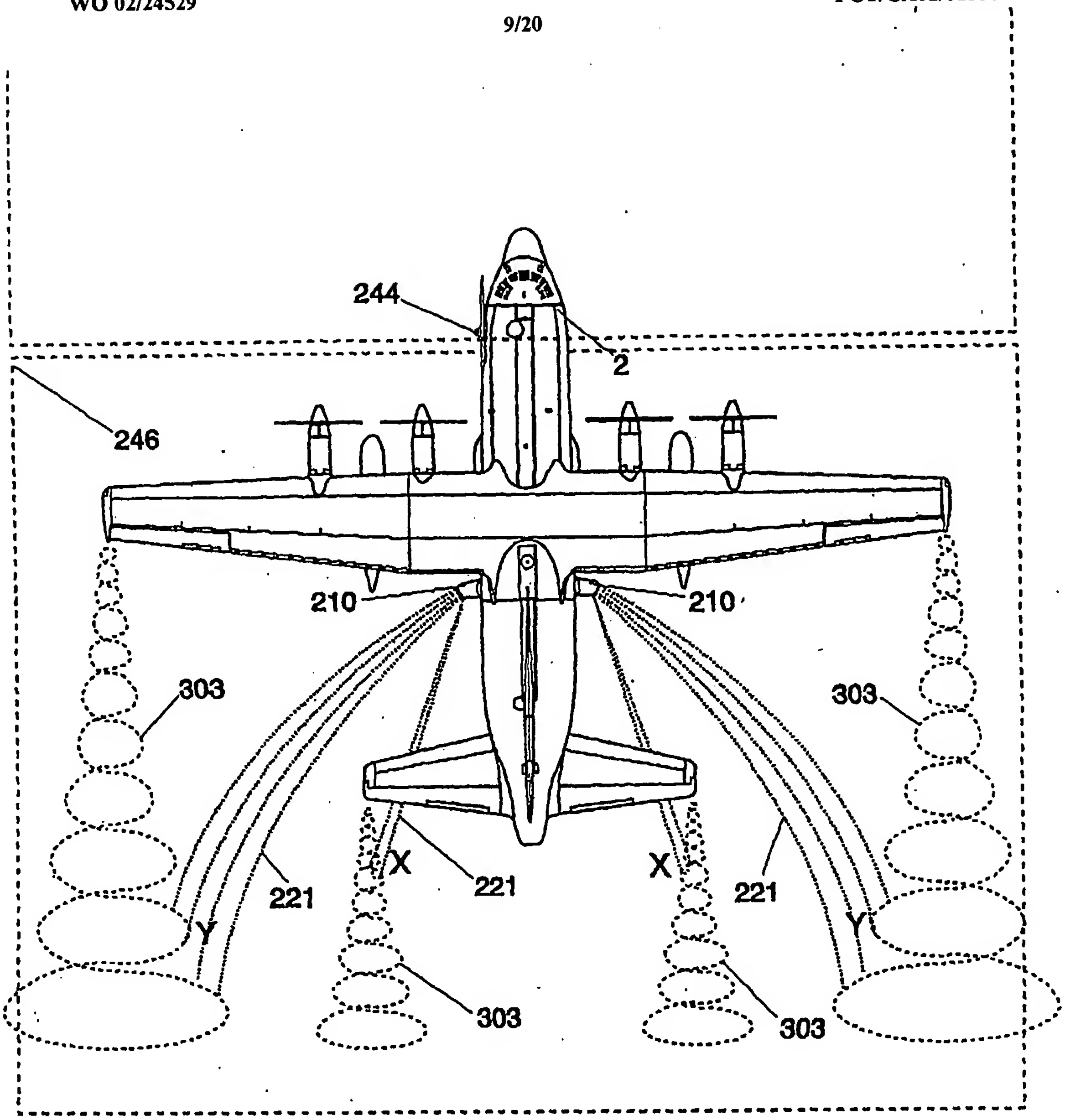


FIGURE 9



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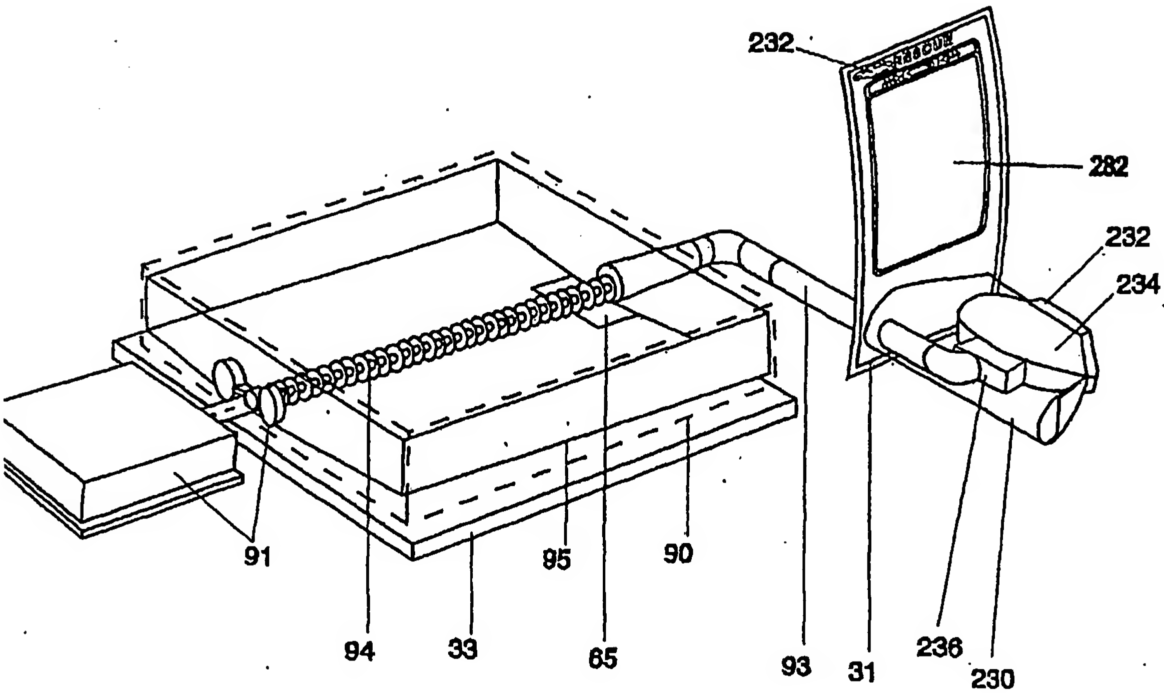
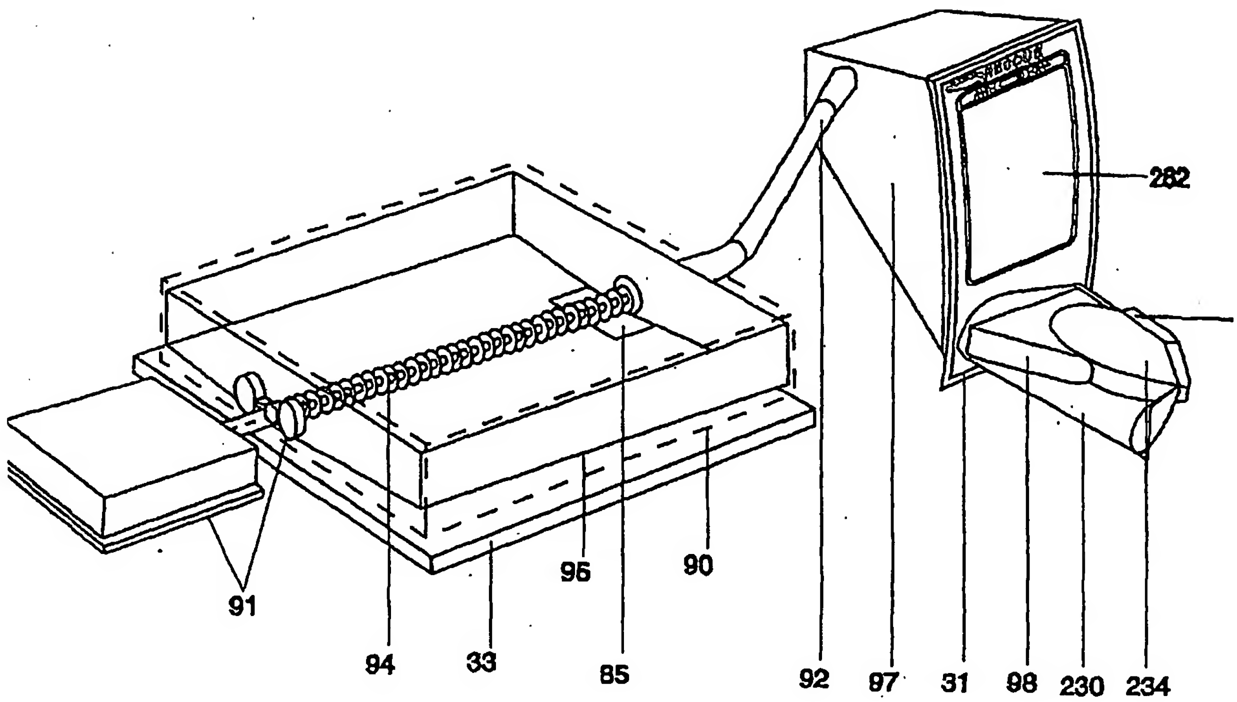


FIGURE 11



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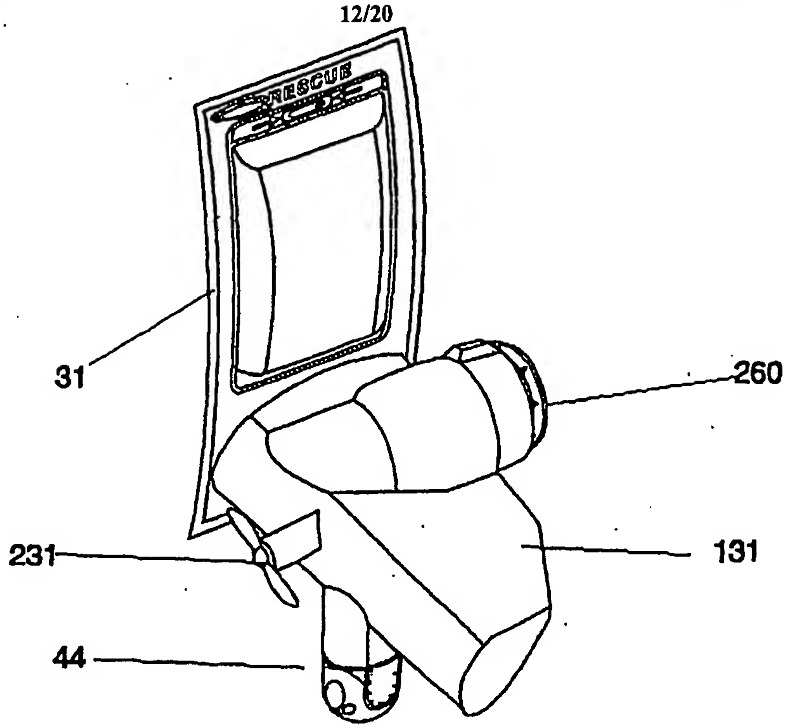
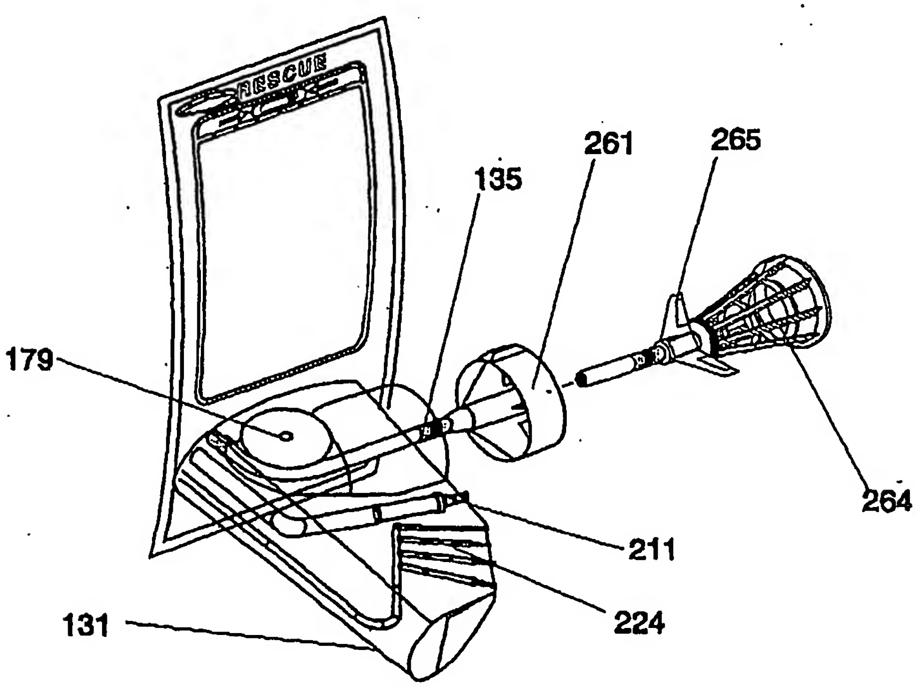


FIGURE 13



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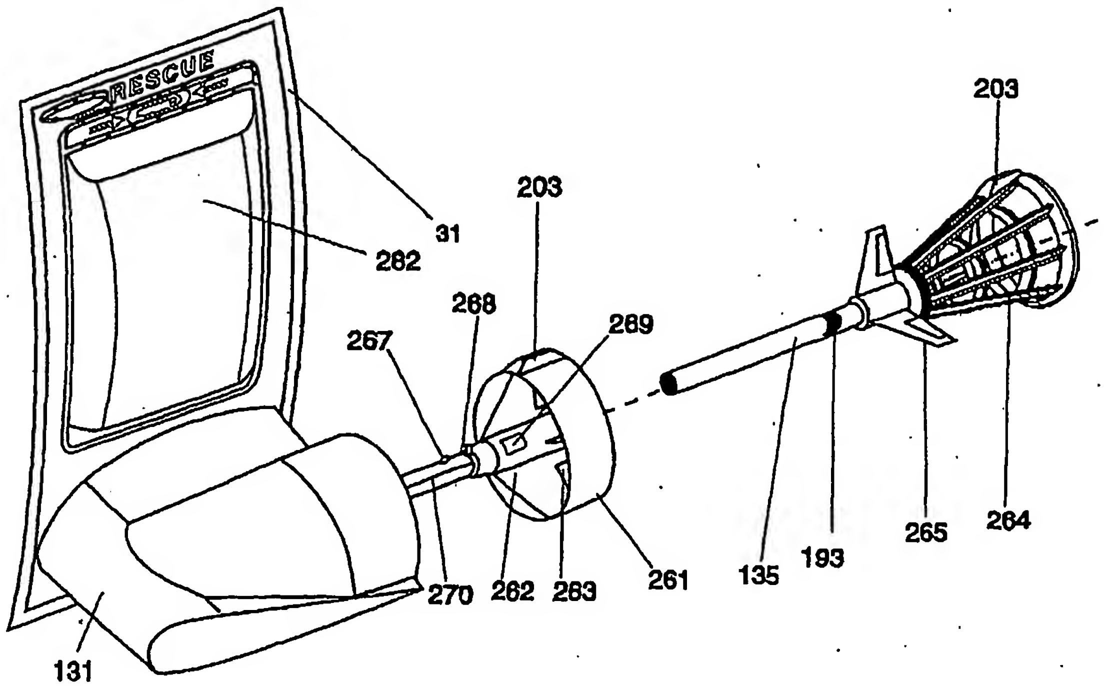
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FIGURE 15

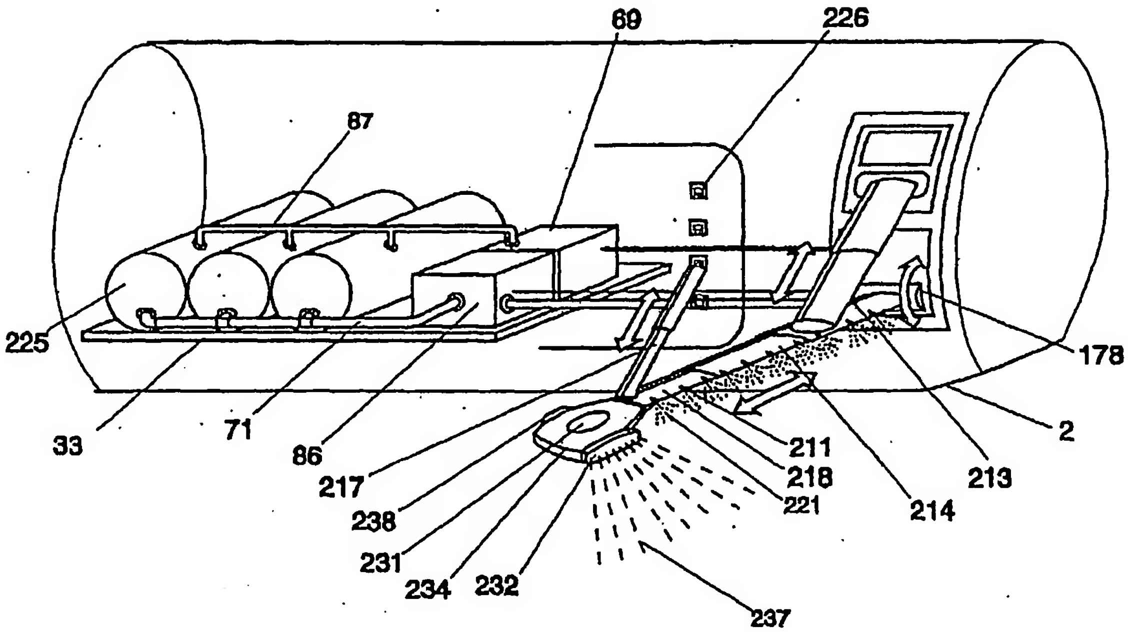
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FIGURE 16

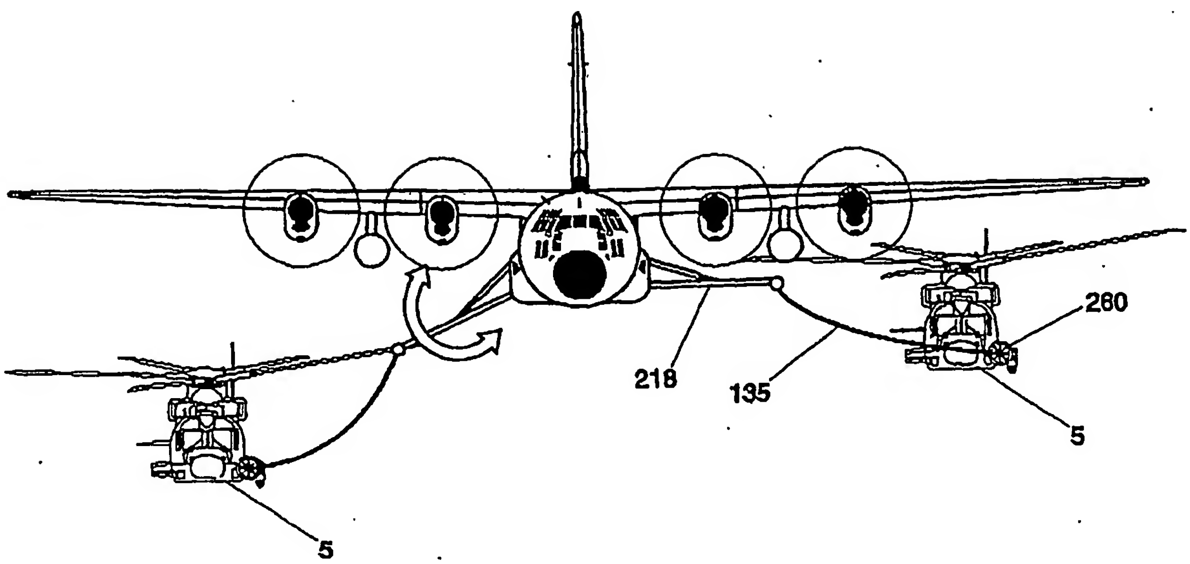


FIGURE 17

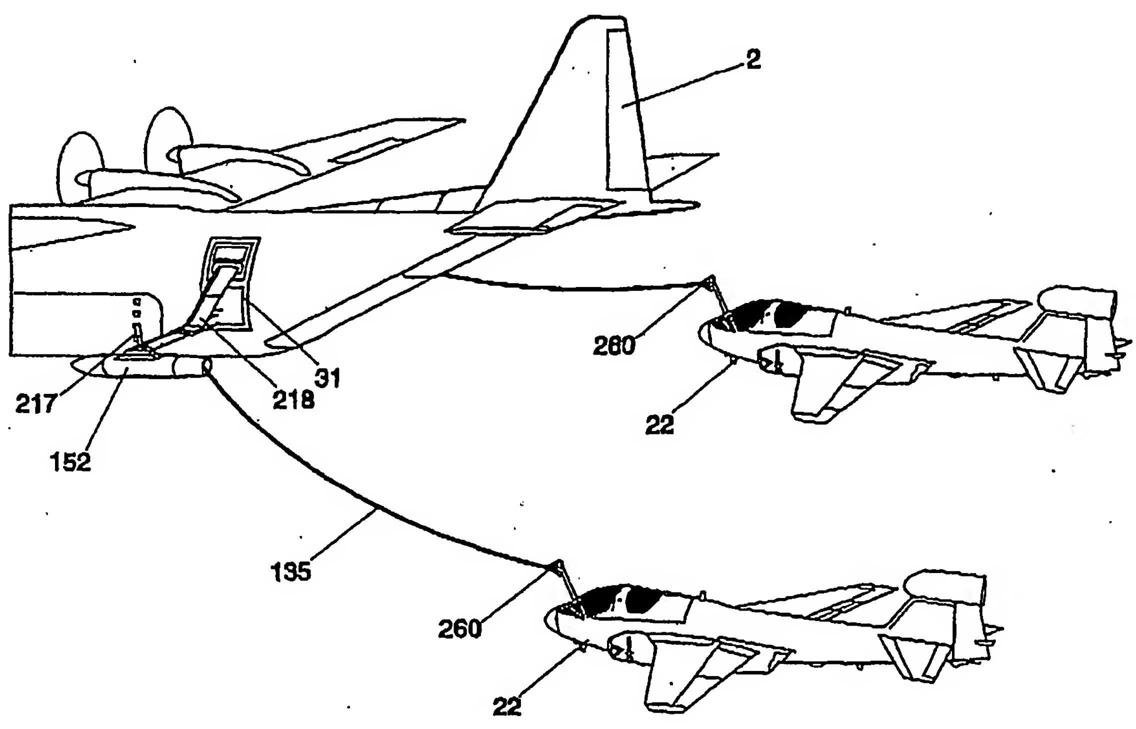


FIGURE 18

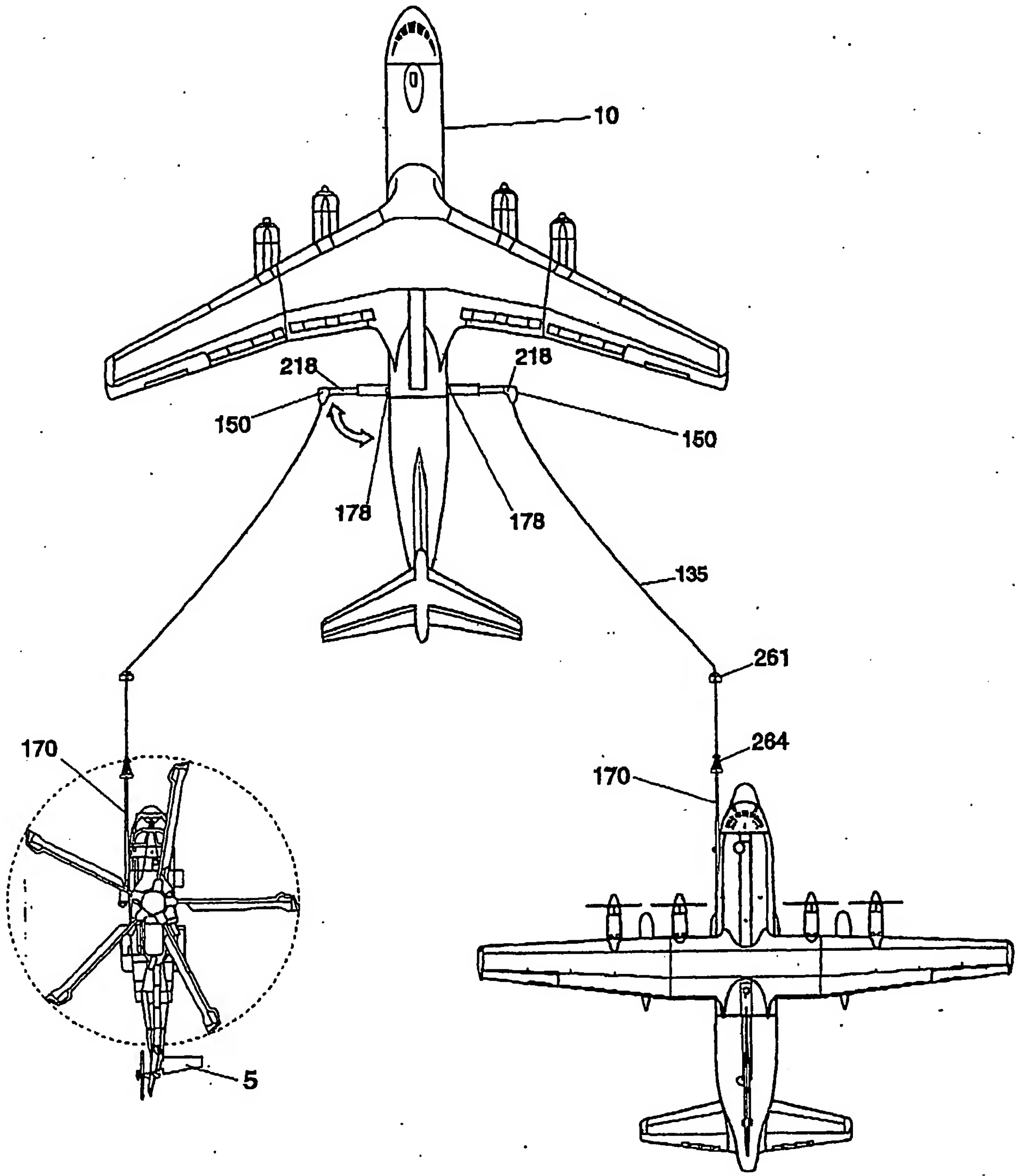


FIGURE 19

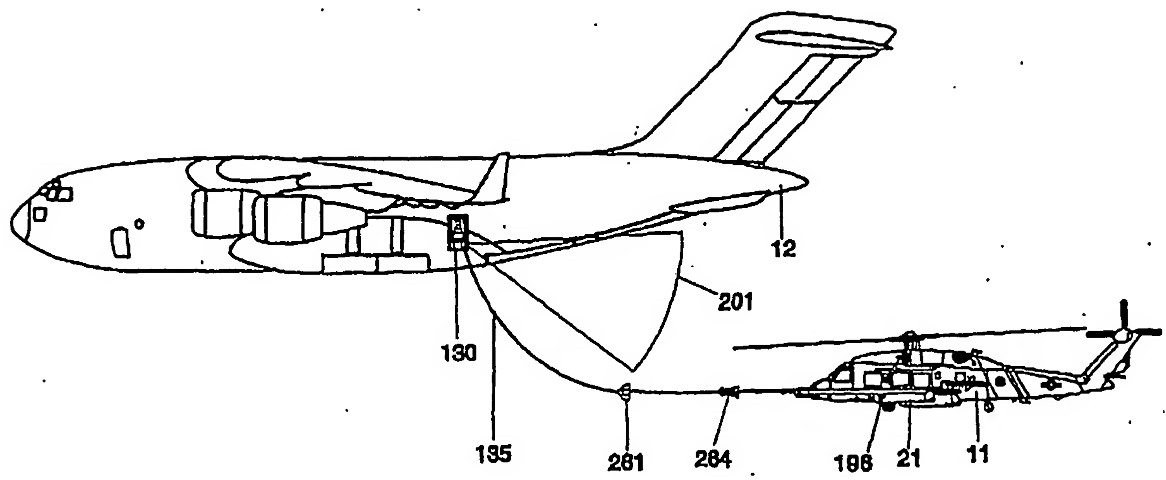
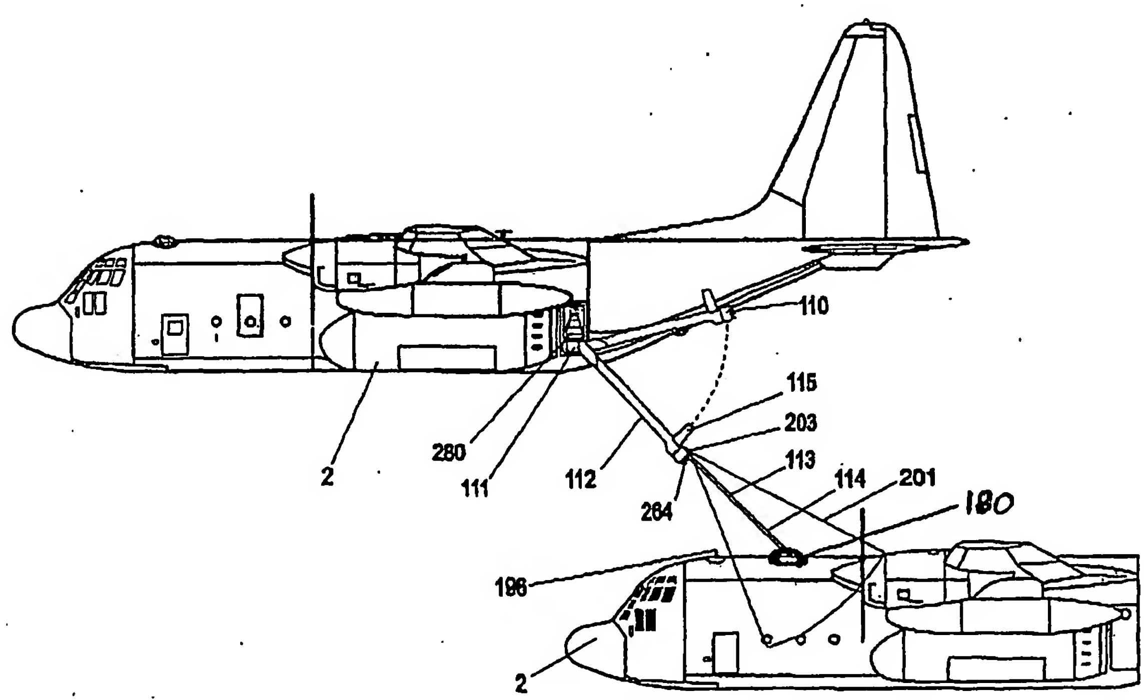


FIGURE 20



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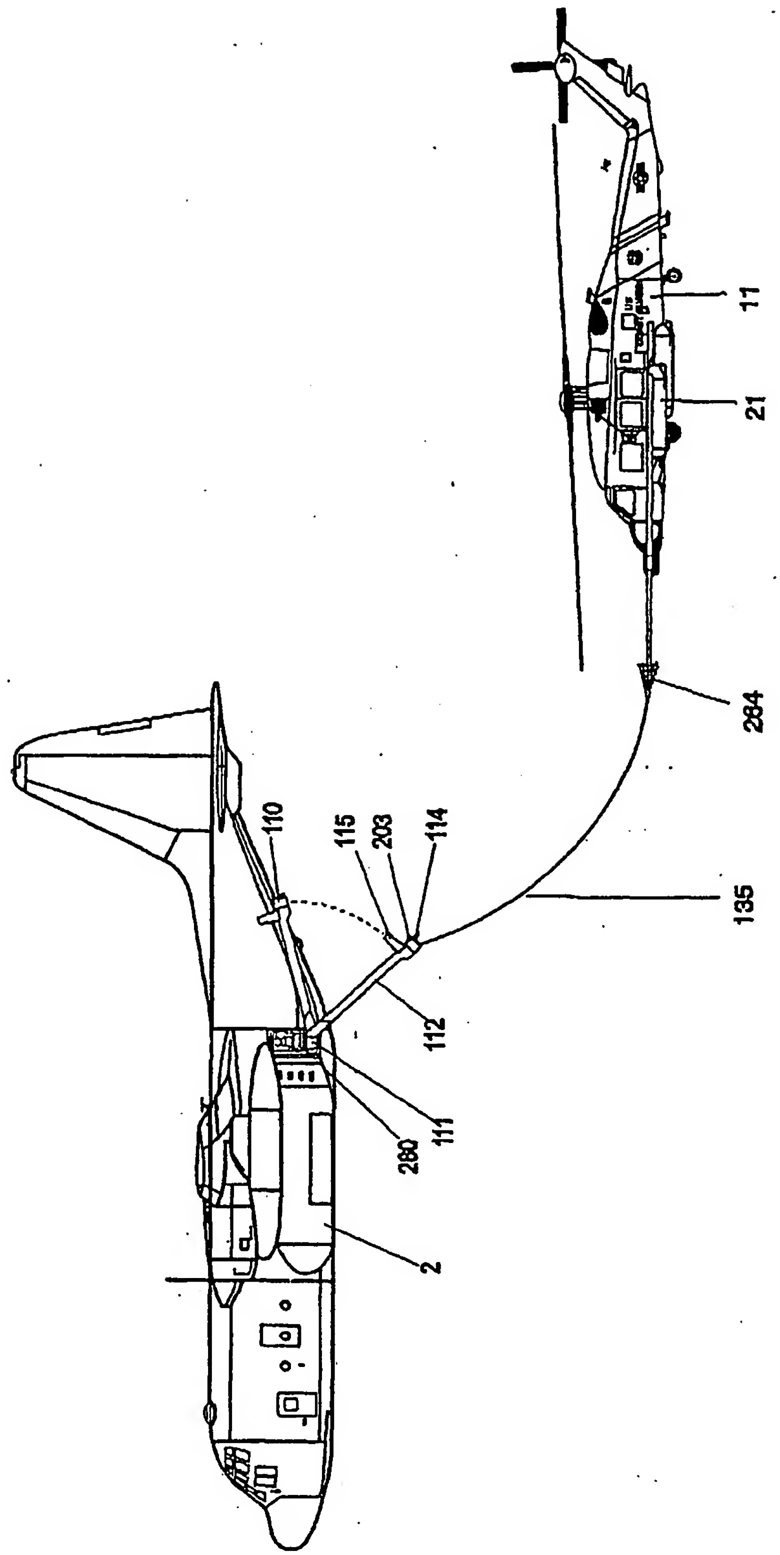

FIGURE 22

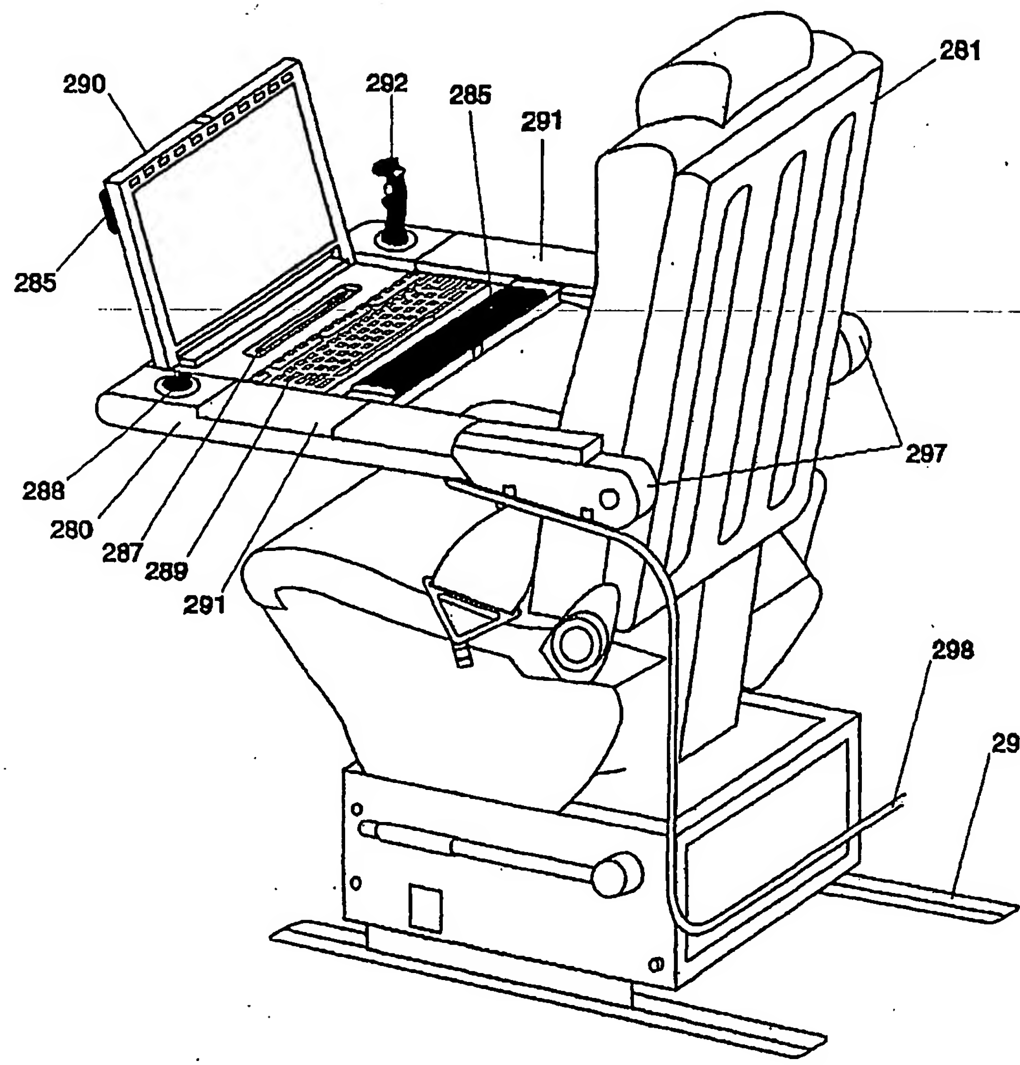

FIGURE 23

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 01/01330

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B64D39/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B64D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 648 428 A (AEROSPATIALE) 21 December 1990 (1990-12-21) page 2, line 19 - line 25	1
A	page 3, line 19 - line 32	2-4,7-11
X	WO 98 07623 A (G UNITARNOE PREDPR PILOTAZHNO ;KVOCHUR ANATOLY NIKOLAEVICH (RU); S) 26 February 1998 (1998-02-26) the whole document	8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 January 2002	22/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hauglustaine, H

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 01/01330

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HEWISH M: "SUPERTANKERS HEAD FOR THE SKIES NEW WIDEBODIES, AIRLIFTERS AND RADICAL AIRFRAMES ARE UNDER STUDY" JANE'S INTERNATIONAL DEFENSE REVIEW, JANE'S INFORMATION GROUP, GB, vol. 33, June 2000 (2000-06), pages 69-73, XP000947400 ISSN: 0020-6512 page 70, column 3, line 1 - line 9	10
Y	US 5 927 648 A (WOODLAND RICHARD LAWRENCE KEN) 27 July 1999 (1999-07-27) cited in the application column 6, line 58 -column 7, line 55 column 9, line 9 - line 58	2,3
Y	US 5 921 294 A (GREENHALGH SAMUEL ET AL) 13 July 1999 (1999-07-13) column 2, line 11 - line 40	2
Y	US 5 906 336 A (ECKSTEIN DONALD) 25 May 1999 (1999-05-25) column 8, line 4 - line 22	3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 01/01330

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2648428 A	21-12-1990	FR 2648428 A1	21-12-1990
WO 9807623 A	26-02-1998	RU 2104229 C1 WO 9807623 A1	10-02-1998 26-02-1998
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US 5921294 A	13-07-1999	NONE	
US 5906336 A	25-05-1999	NONE	